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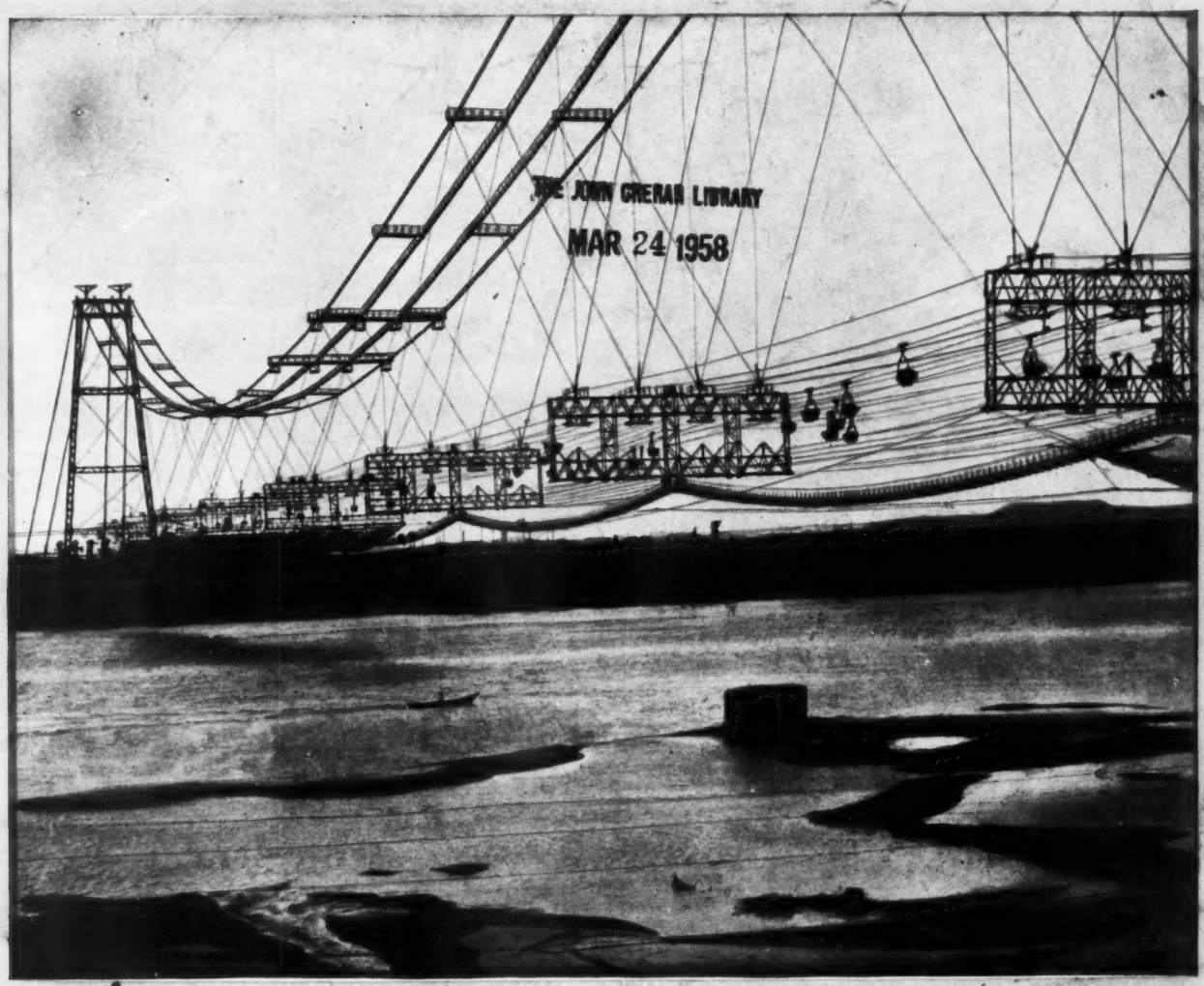
INDIAN JOURNAL OF POWER & RIVER VALLEY DEVELOPMENT

VOL. VII. NO. 10 OCTOBER 1957 RUPEES TWO



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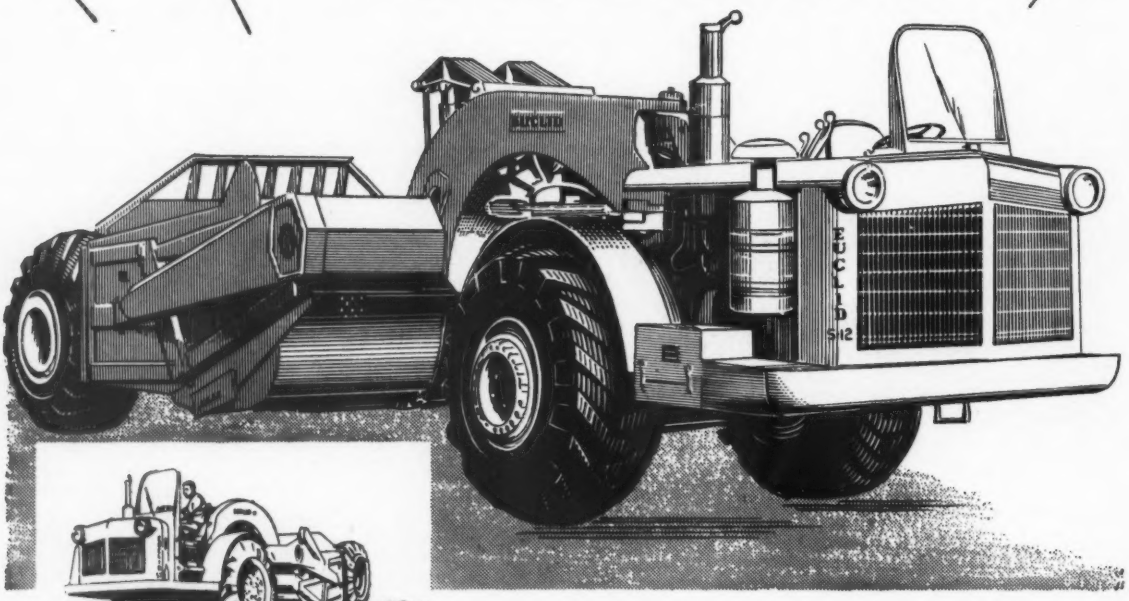

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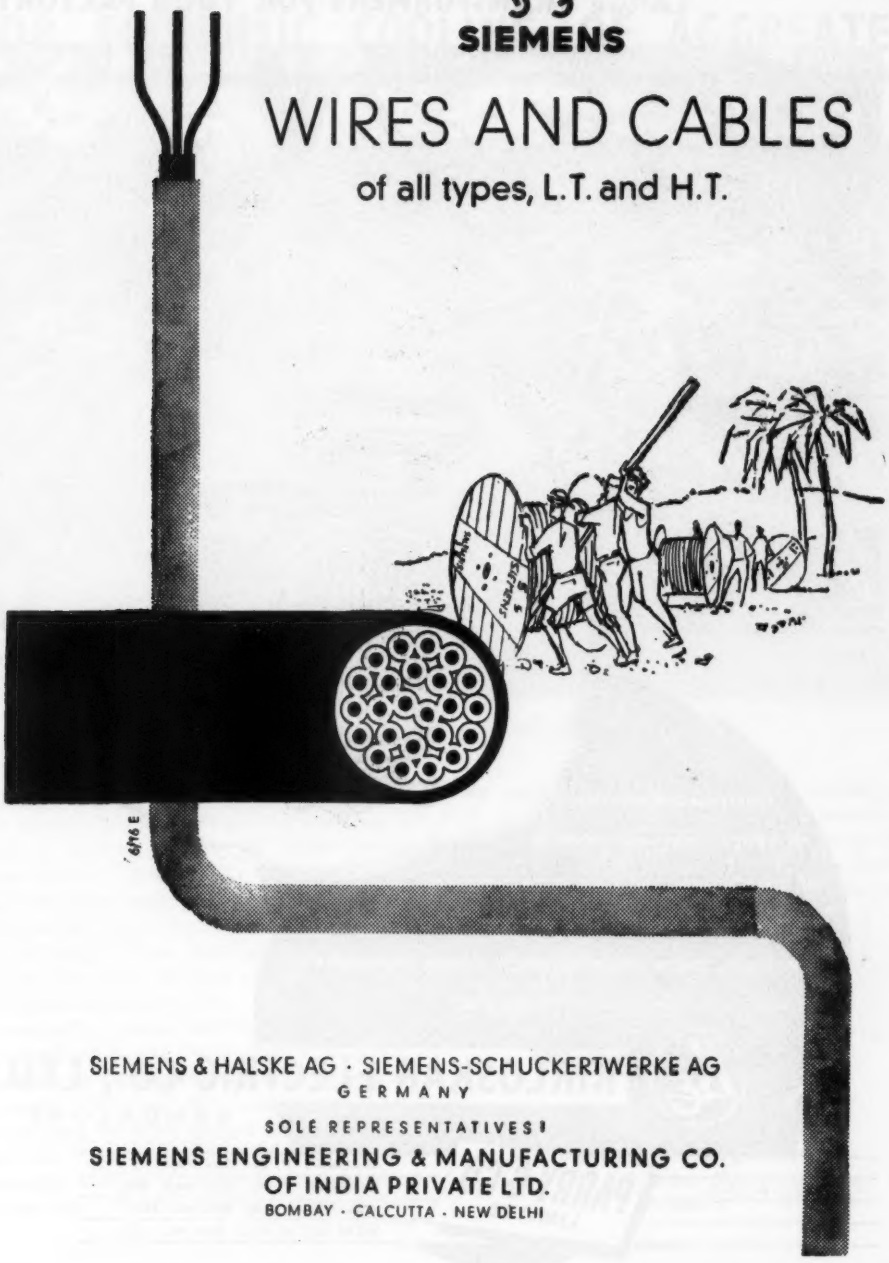

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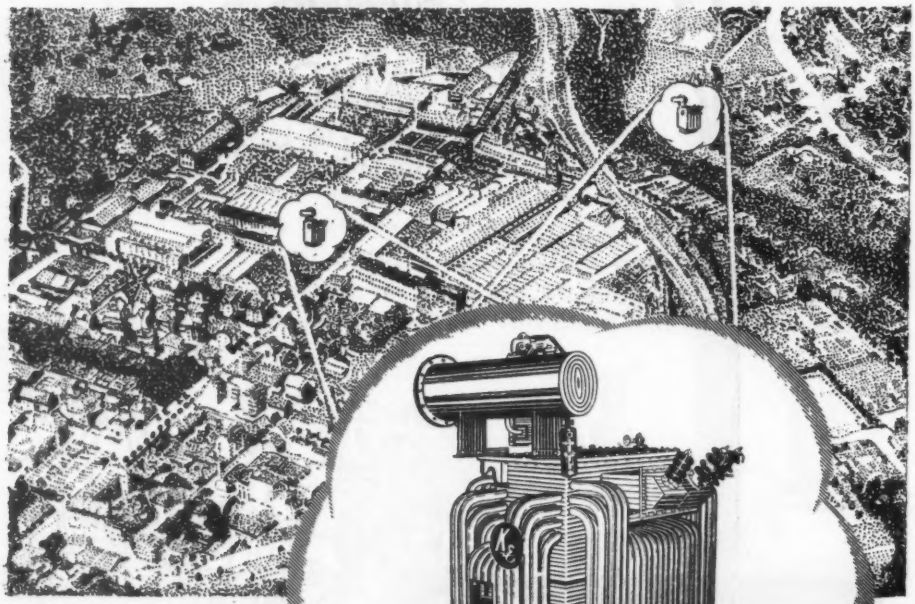

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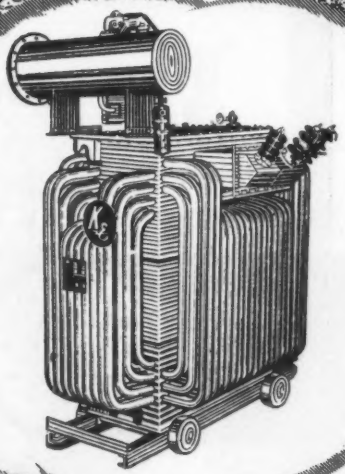

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INDIA PIONEERS ORIGINAL METHOD

FOR ECONOMIC COOLING OF AGGREATES

A view of the Aggregate Cooling plant which was installed at Vaitarna, (Bombay).

India made a unique experiment when in the First Plan period a "Carrier" refrigeration plant was installed at Vaitarna, Bombay, by Volkart Brothers (predecessors of Voltas Limited) in conjunction with Hindustan Construction Co. Ltd., for pre-cooling aggregates and sand to a pre-determined temperature with the help of chilled water and air, so that the concrete mix might not gain a temperature above 60°F at the time of placement. This method proved an outstanding success besides being economical, continuous and quick. In the wake of this success, the Hindustan Construction Co. Ltd., are adopting the same process for the construction of the Rihand Dam, for which purpose they have placed orders with Voltas Limited for a 500 BHP "Carrier" Centrifugal Machine to enlarge the capacity of the previous plant. That the same method for pre-cooling aggregates will be used for the construction of the Koyna Dam, by the main contractors, Messrs. Shah, Salzgitter & Jolly Ltd., speaks eloquently of the popularity of the aggregate cooling plant utilising the "Carrier" Centrifugal Machine.

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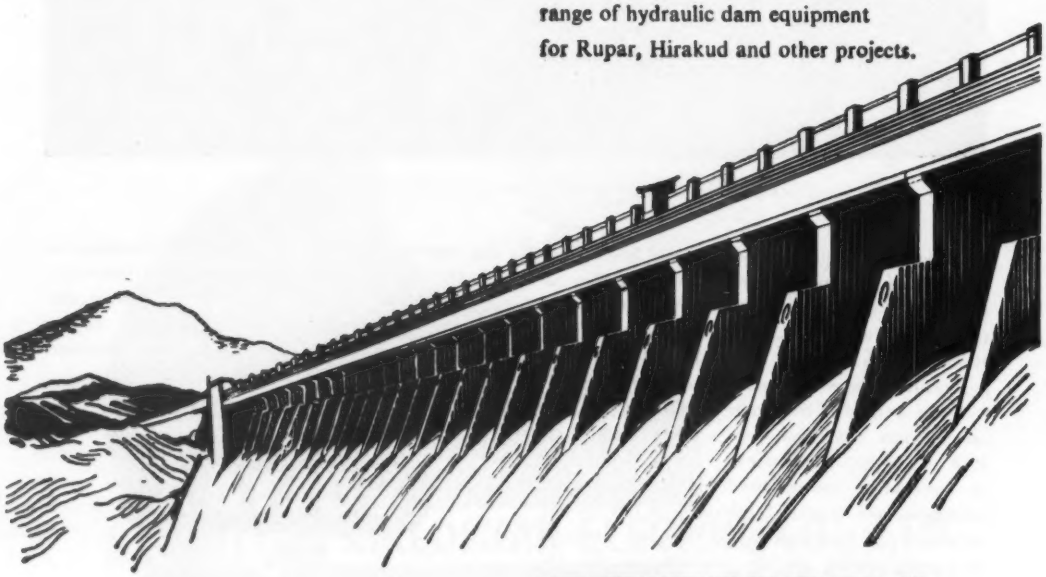

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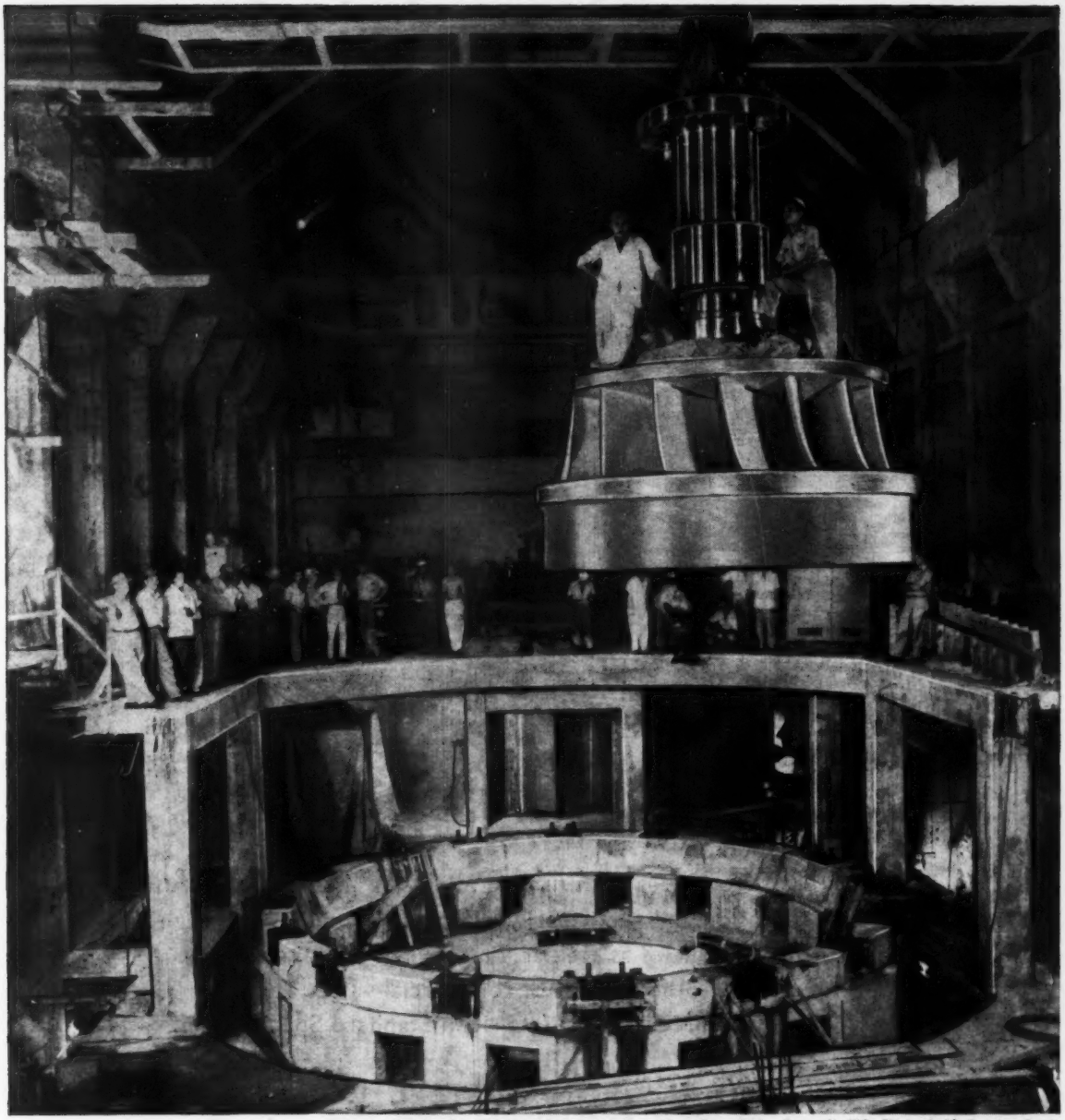

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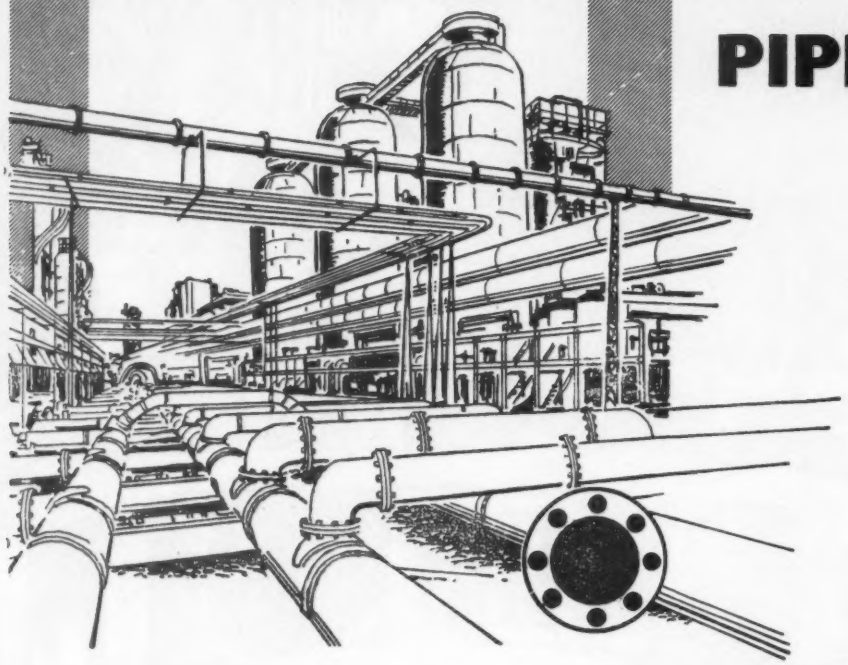

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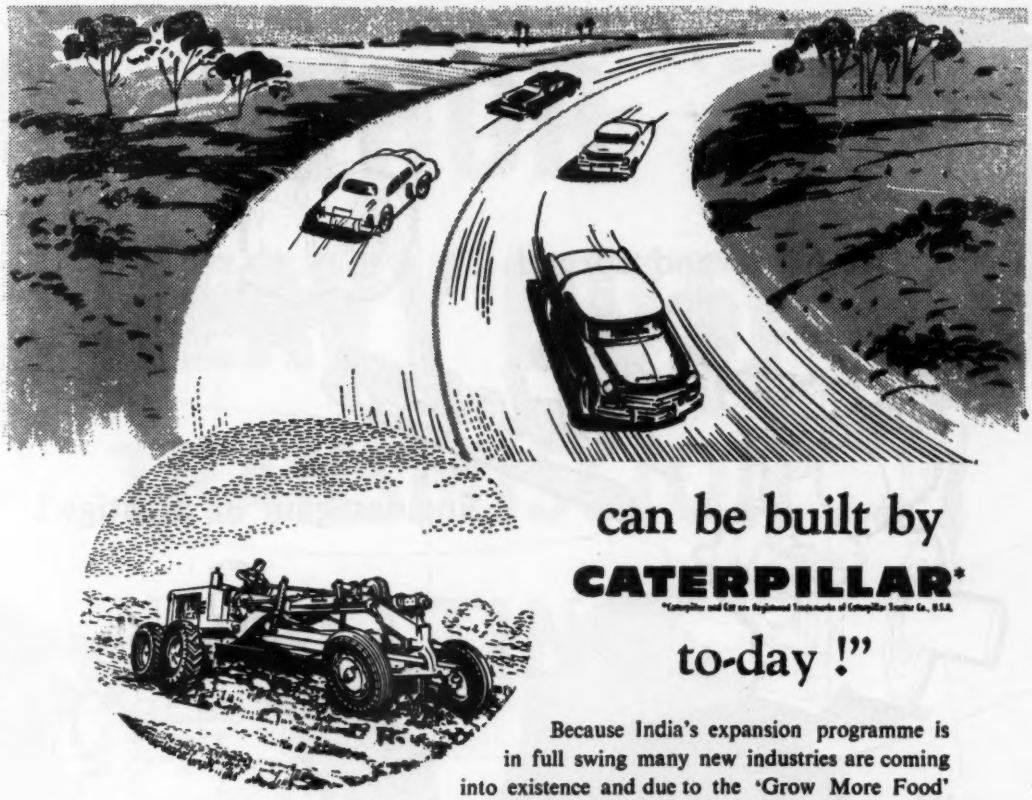

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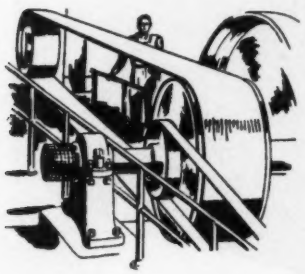

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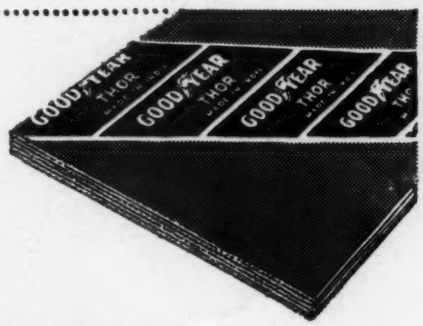

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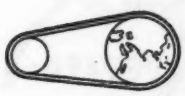

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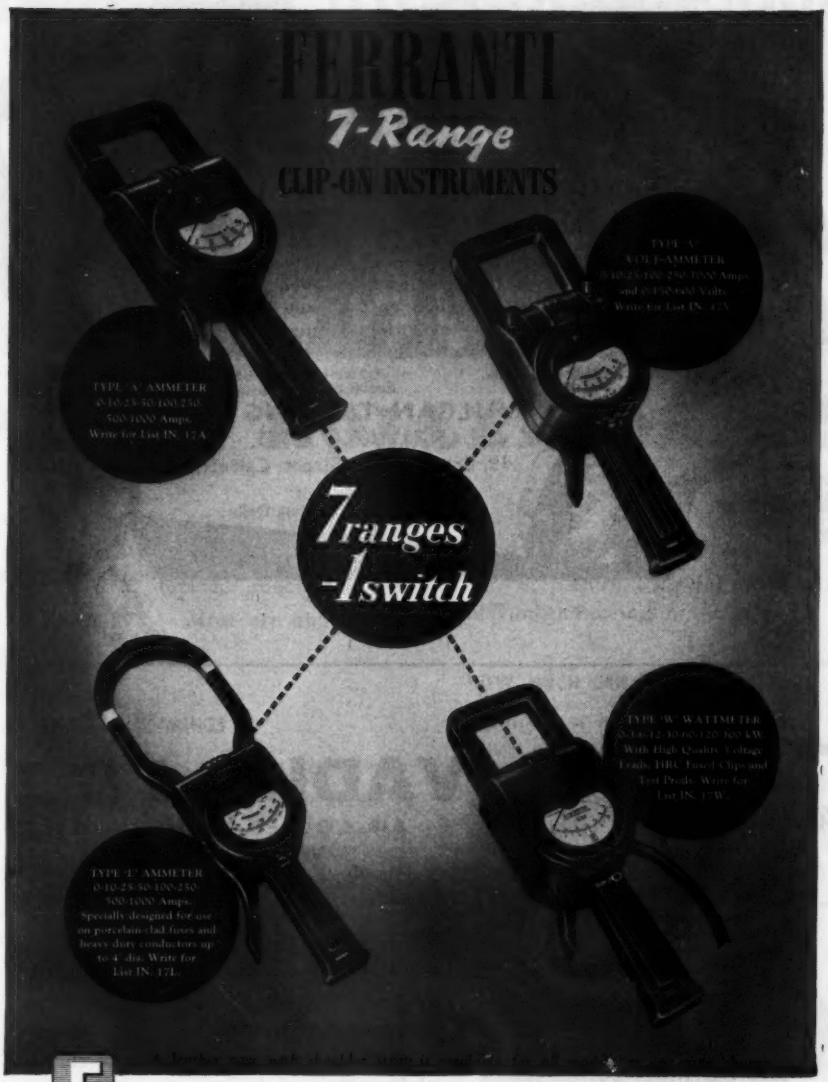

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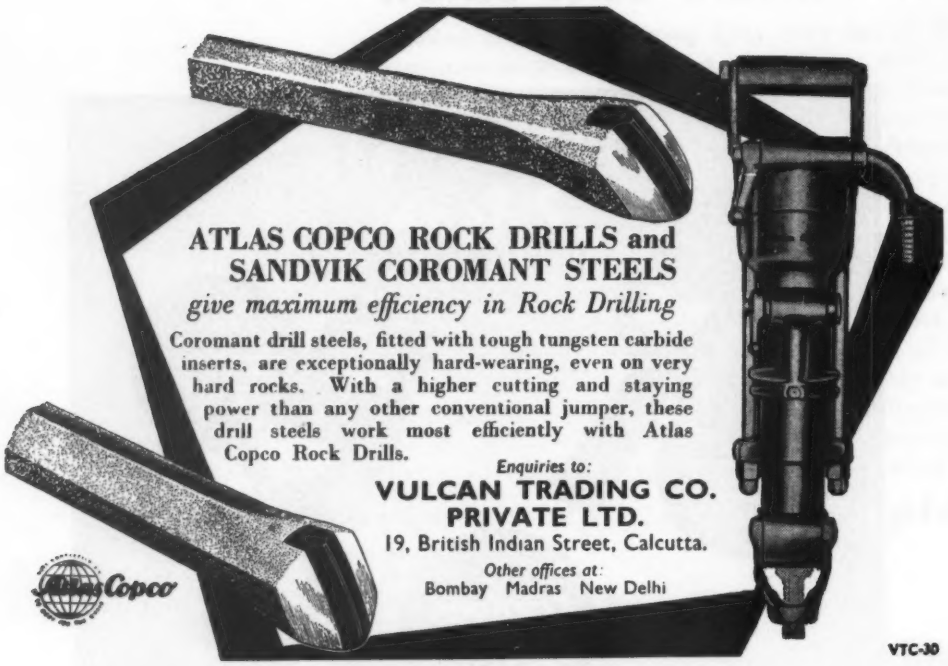

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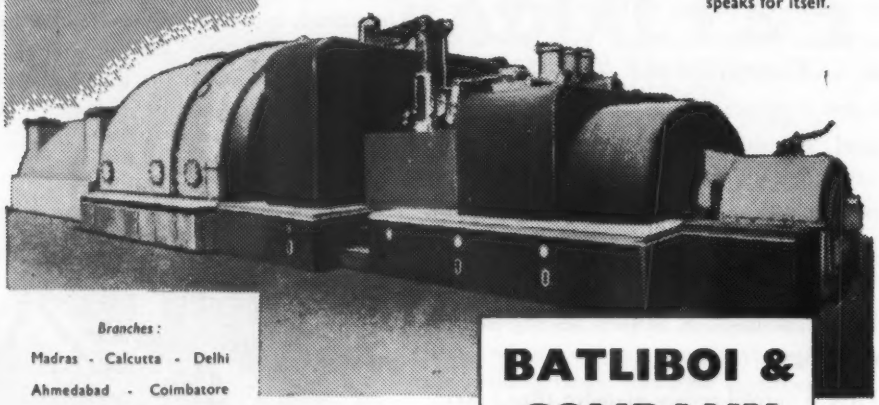

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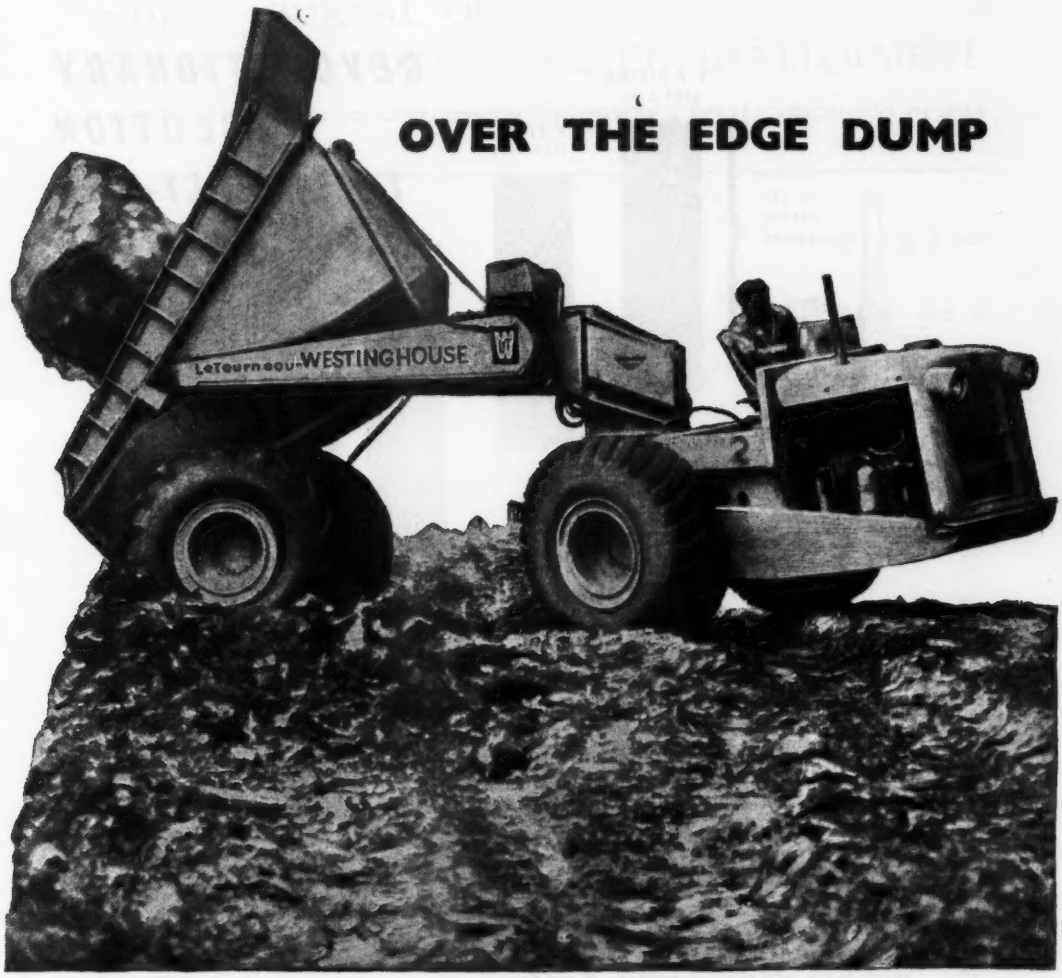

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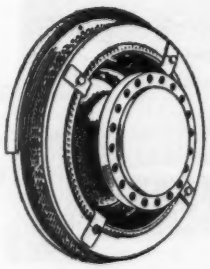

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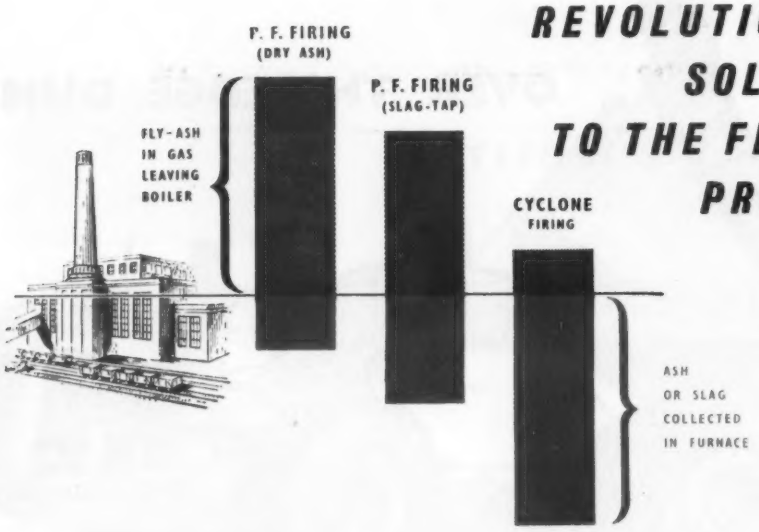

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Highest boiler efficiency due to efficient combustion, cleaner boiler surfaces, and lower power consumption for coal preparation—since the coal need only be crushed or coarsely pulverized.

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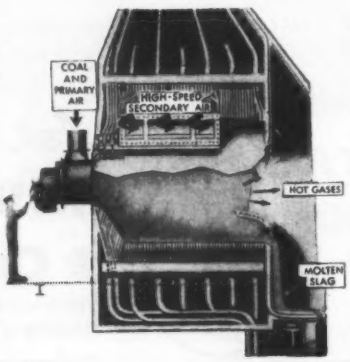

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A MONTHLY DEVOTED TO DEVELOPMENT OF POWER & WATER RESOURCES IN ASIA

Editor : K. K. Sinha

P. K. Menon : Mg. Editor

VOL. VII **OCTOBER 1957** **NO. 10**

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The Canada-India Reactor : its design and operating features *by* F. J. Bleackley; Mangla Dam Project; Silt in Relation to Irrigation and Power Projects *by* K. M. Tiwari; Notes and News; Utilisation of Irrigation Facilities

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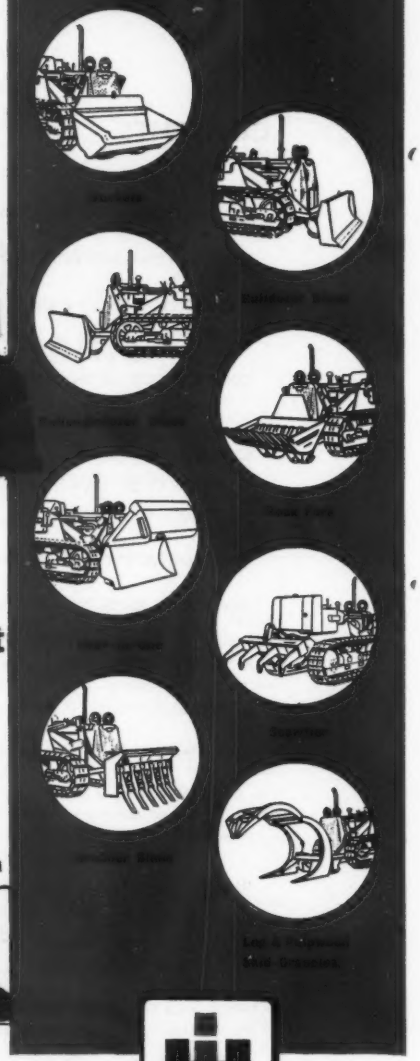

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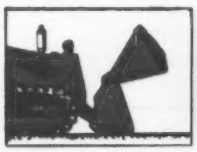
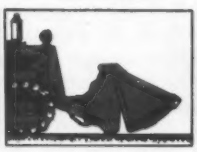
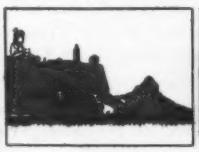


Versatile Bullclam



Big-capacity Skid-Shovel



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VOL.877

Stalingrad Hydro-electric Station

By G. RUSSO

The Volga is the biggest river in Europe, with an overall length of 3,688 km., a gradient of 256 metres, and a mean annual drainage of 251 km³. The Volga and its biggest tributary, the Kama, flow through densely populated and industrially developed districts of the Soviet Union and are therefore of great importance for the national economy.

Before 1917 the Volga and the Kama were used only as water transport arteries. The construction of hydro-electric stations on these rivers was then beyond the power of the extremely backward economy of Russia. All-round utilization of the Volga and the Kama commenced in recent times in connection with the rapid development of the country's national economy and its radical reconstruction.

In 1932 construction of the Moscow-Volga canal was launched. To collect water in this canal, there was built on the Volga the Ivankovo hydro-development, which also included a hydro-electric power station.

In 1934 work on the Uglich and Rybinsk hydro-developments got under way. Further hydro-electric power development on the two rivers unfolded on a broad scale after the war of 1941-1945.

On the basis of data furnished by detailed field studies and critical designing studies, it is planned to build a cascade of nine hydro-electric stations on the Volga and four on the Kama. These stations will produce a total of 50,000,000,000 kWh of electrical energy during mean annual drainage years and will have an overall rated capacity of some 11,000,000 kW.

The biggest of these stations are to be the Kuibyshev (with a capacity of 2,100,000 kW), scheduled for completion this year, and the Stalingrad (with a capacity of 2,310,000 kW), now under construction.

The Stalingrad hydro-development consists of a hydro-electric power station, a concrete spillway, an earthen dam, and navigation locks. The total length of structures bearing the hydraulic pressure head runs into some 5 km. A railway and a highway are to run across them.

The lay-out of the hydro-development scheme has been conditioned by the geological structure of the Volga River valley and the established order of executing the job.

The right bank of the river and its bed are built up of tertiary sand and clay rock formations that gently subside to the southeast. Close to the left bank there is a tectonic fault with an amplitude of about 200 metres that passes along the river valley. To the east of the fault, the Volga floodland and its left bank are built up of quarternary sands and clays to a considerable depth.

In building the Volga hydro-development schemes the following order is adhered to everywhere in putting up the structures with a view to speeding up the work. First the concrete structures and sections of the earthen dam are erected beyond the coffer dams of the floodlands. The main channel of the river is used at this time for passage of water and for navigation. After the concrete structures for passage of water are ready, the river channel is blocked by a rock banquette. Then, under its protection, the river-channel section of the earthen dam is built.

With these circumstances taken into consideration, the concrete spillway and the Stalingrad hydro-electric station itself are located to the west of the fault on the floodlands, where bedrock serves as their foundation and will decrease erosion in the tailwater of the spillway structures.

The main channel of the river will be blocked by an earthen dam. The navigation lock is to be on the left-bank flood plane.

Construction of the hydro-electric station involves the blocking of the Akhtuba, an arm of the Volga on the left bank. To keep the populated points along the Akhtuba supplied with water, maintain local navigation and irrigate the surrounding land, a special canal, the Volga-Akhtuba, has been built.

The structure housing the hydro-electric station will be 737 metres long, 90 metres wide and 71 metres high. It is divided into 12 sections by joints.

Twentytwo 105,000 kW generating units are to be installed in the station. Each unit will consist of an adjustable blade turbine with a 9.3-meter rotor and a generator.

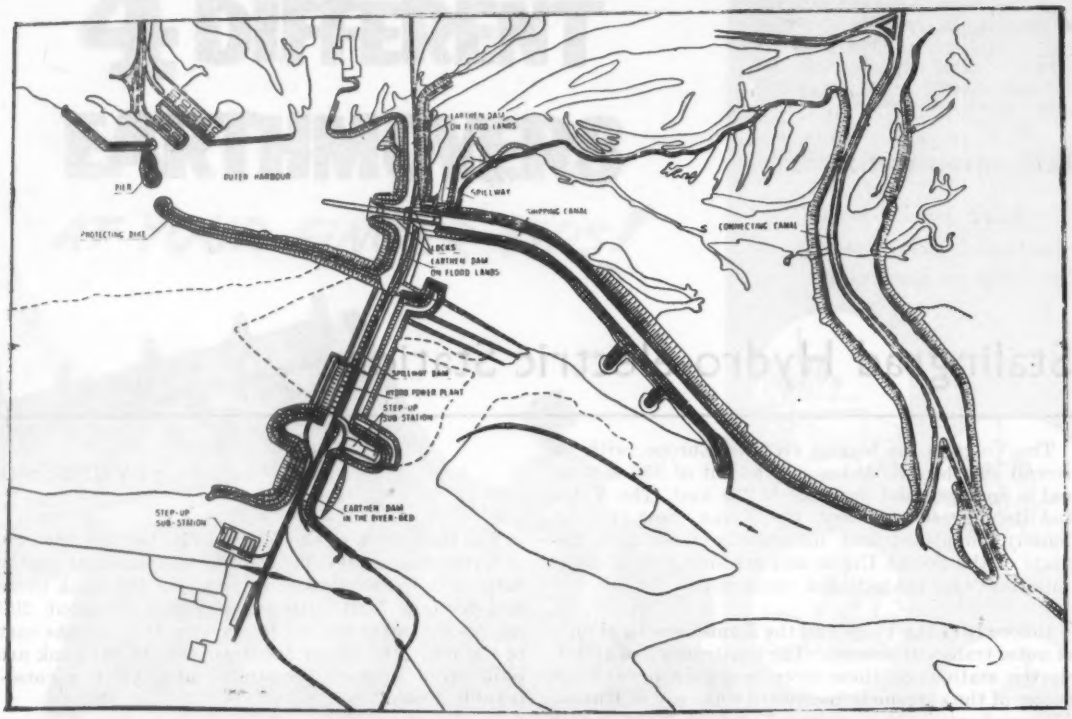


Fig. 1.—General plan of the Stalingrad Hydro-electric project

Two 450-ton overhead travelling cranes will be installed in the machine room.

Experience gained in the exploitation of a number of Volga hydro-electric stations has shown that their gratings become considerably clogged with refuse. As a result, the stations lose a lot of electrical energy, especially in the period of high water, when all the generating units can operate. To avoid such losses, the Stalingrad hydro-electric station is to be equipped with a special refuse retaining structure.

Besides the generating units, there are spillway openings in the hydro-electric station, these begin

Fig. 2.—The construction of the locks.

under the spiral chambers and enter the tailwater above the suction pipes.

Of a total rated flood-water consumption of 61,000 cubic metres per sec., it is planned to send 30,000 cubic metres per sec. through the station, including 15,700 cubic metres per sec. through the spillway openings. A combined type of hydro-electric station like that will make it possible to curtail the length of the spillway dam and cut down production costs. Furthermore, the spillway openings are used to pass through construction wastes and, by means of ejection, increase the pressure head on the turbines during the period of high water.

On a massive reinforced concrete base plate stands the spillway proper, divided by buttresses at intervals of 20 metres. Both the operation and repair gates are flat. They are serviced by portal cranes.

Taking into consideration the considerable constraint to which the Volga is subjected, the presence of excess kinetic energy in the current after it has passed through the spillway, and the clarifying of the water in the reservoir, strong reinforcements are envisaged below the dam and the hydro-electric station. The basic dimensions of these reinforcements have been determined by testing models. The end part of the down-apron should insure its strength even when the ground beyond it has been eroded. Specific consumption per linear metre of the hydro-electric station and the dam is to be equal to 45 cubic metres per sec.

The earthen dam is being made of one material only —sand. Its maximum height above the bed is to be 47 metres. The slope of the dam facing up-river is to be protected by reinforced concrete slabs from 0.55 to 0.4 meter thick.

The navigation structures consist of two rows of two-stage reinforced concrete locks filled longitudinally, a spillway, an approach canal from the tailwater side, and earthen dikes protecting the road in the headwater.

Construction of the Stalingrad hydro-electric station will involve the execution of 148,000,000 cubic metres of earth work, the laying of 6,600,000 cubic metres of concrete, and the assembly of 72,000 tons of metal constructions and mechanisms.

The main construction site of the hydro-development scheme spreads out on the left bank of the Volga. To transfer crushed rock, sand and stones from the right bank to the left, an overhead cableway has been erected.

The Stalingrad hydro-electric station will produce some 11,500,000,000 kWh of electrical energy during mean annual drainage years. Of this total, it is planned to transmit 4,200,000,000 kWh to the Moscow Power System, 1,300,000,000 kWh to the districts of the Central Black Earth Region, 5,000,000,000 kWh to the Volga area and 1,000,000,000 kWh to the Donbas.

More than 1,000 km of 500-kV transmission lines and 4,000 km of 220 and 110 kV transmission lines are to be built to deliver the electrical energy. In the Donbas there is to be a high-voltage transmission line about 600 km long designed to carry an 800 kV d.c. current.

Transmission of electrical energy over such a great distance will be profitable since the current generated by the Stalingrad hydro-electric station will be 4 to 5 times cheaper than that produced by steam power plants. Besides, construction of the mentioned electric transmission lines is part of the program for creating a single high-voltage power grid in the European part of the USSR.

One of the components of the Stalingrad hydro-

Fig. 3.—General view of the foundation pit of the power station and the spillway dam.

[*Continued on page* 17

Koyna Hydro-electric Project

By N. G. K. MURTI

The highly industrialised city of Bombay and surrounding area, at present served by the Tata Central Railway interconnected system is experiencing a severe power shortage. The Koyna possesses total power potential of about 500,000 kW, the water allocated for power generation being 67,500 m. cft. This power potential is proposed to be developed in three stages. The first stage will generate 240,000 kW (about 1200 million kilowatt-hours). About 200,000 kW of this power will be made available to meet the awaiting demand. It is expected that the load from the adjoining Maharashtra country will be of the order of 18,000 kW by the time these load centres are connected with the Koyna System. The load growth in this area is expected to be about 4000 kW per year, so that by 1966 this demand will be about 39,000 kW.

Location

The scheme is located on the Koyna river, which is a tributary of the river Krishna. The Koyna has its source on the table land of Mahabaleshwar and proceeds between it and the Pratapgad in the southern direction for about 40 miles and then takes a right-angle turn to flow east for about 35 miles, and meets the river Krishna at Karad.

All the Deccan plateau rivers start in the Western Ghats, and flow in the eastern or the south western directions, so that they have high rain-fall of 150" to 250" at their source only. The Koyna is an exception in this respect, in that it flows in a north-south direction and parallel to ghats for the first forty miles from its source and has a rain-fall of over 200" in all this length of its course. It, therefore, collects considerable quantities of water, which wil be stored by the proposed Koyna Dam.

Excavation for foundation of the Dam in Monoliths Nos. 16 to 20.

The dam-site is at Deshmukhwadi, a village 3 miles north in the Koyna Valley from Helwak, a village on the Karad-Chiplun road, 35 miles from Karad and 26 miles from Chiplun.

Communication

The main artery of communication to the work-site is the Karad-Chiplun road mentioned above. It is an all-weather black topped road. The rail-head is Karad — a station on the Poona Bangalore meter guage section of the Southern Railway. State Transport buses run from Karad to Koyna, Pophali and on to Chiplun, also direct from and to Poona. Pophali can be reached by Bombay-Ratnagiri (Via Chiplun) or Bombay Chiplun State Transport Service with suitable connecting services directly from Bombay.

There is another route which is by the sea. The Vasisthi river in the valley of which the power house is located, joins the sea at Dabhol, where the coastal steamers from Bombay can touch. The Vashisthi gets sea tides upto Chiplun and is navigable upto Govalkot, which is 1¼ miles from Chiplun. Crafts suited to a draft of 4 to 5 ft. can go upto Govalkot. Machinery, material and equipment can be brought by sea, via Dabhol to Govalkot. From there they can be taken to Pophali by road.

Detailed description of the work site

The works of the Koyna Project are located at three places :

(*a*) The dam is located at Deshmukwadi, 3 miles to the north of Helwak in the Koyna Valley. The Koyna river bed here is about 1900 ft. above the mean sea level.

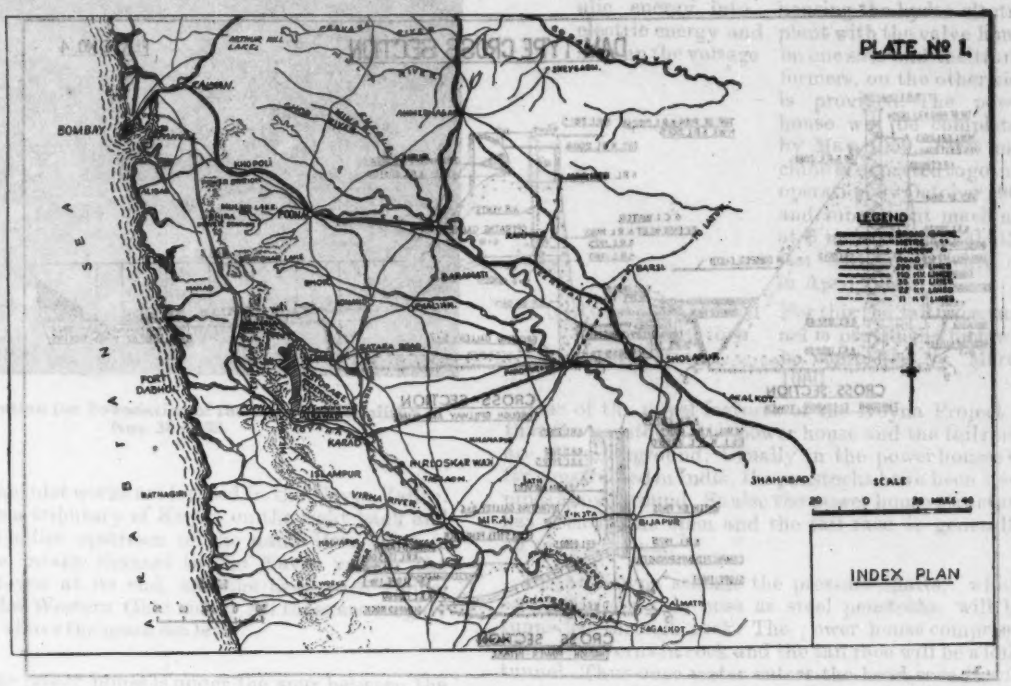
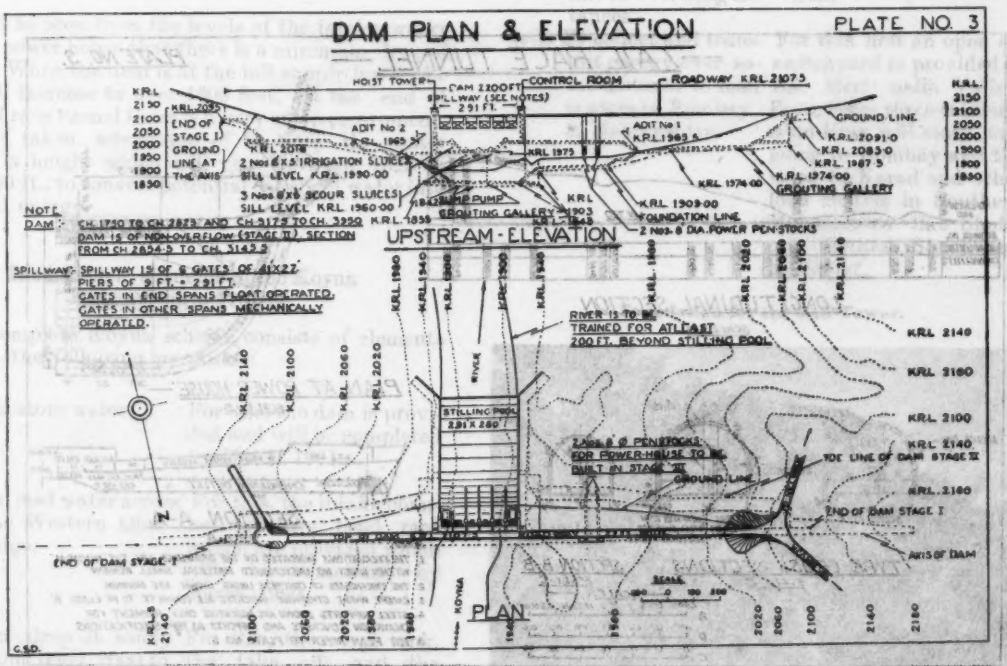
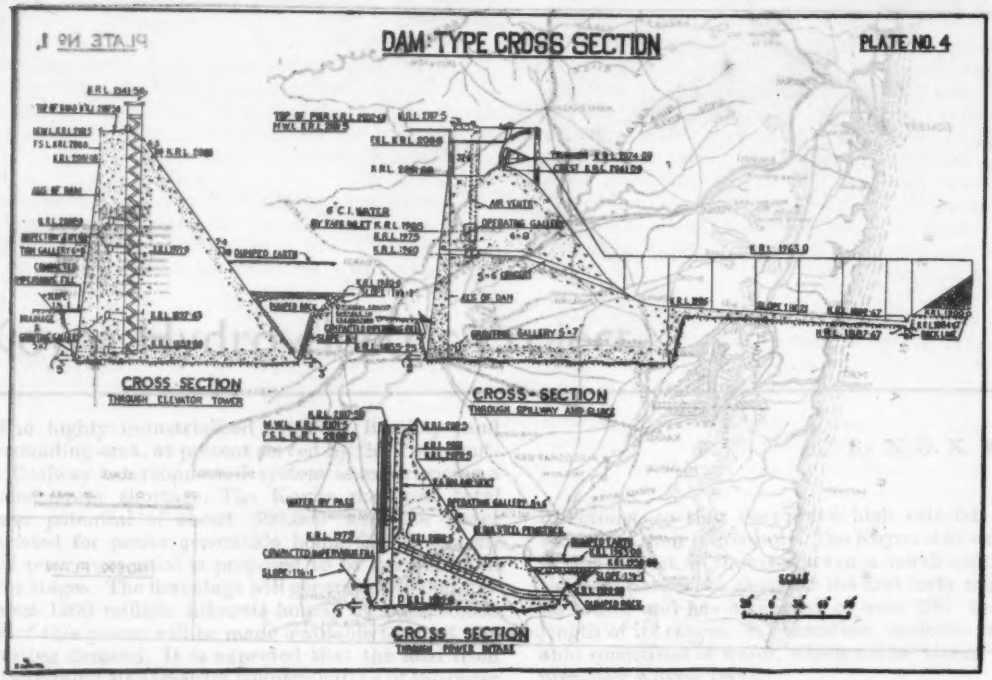
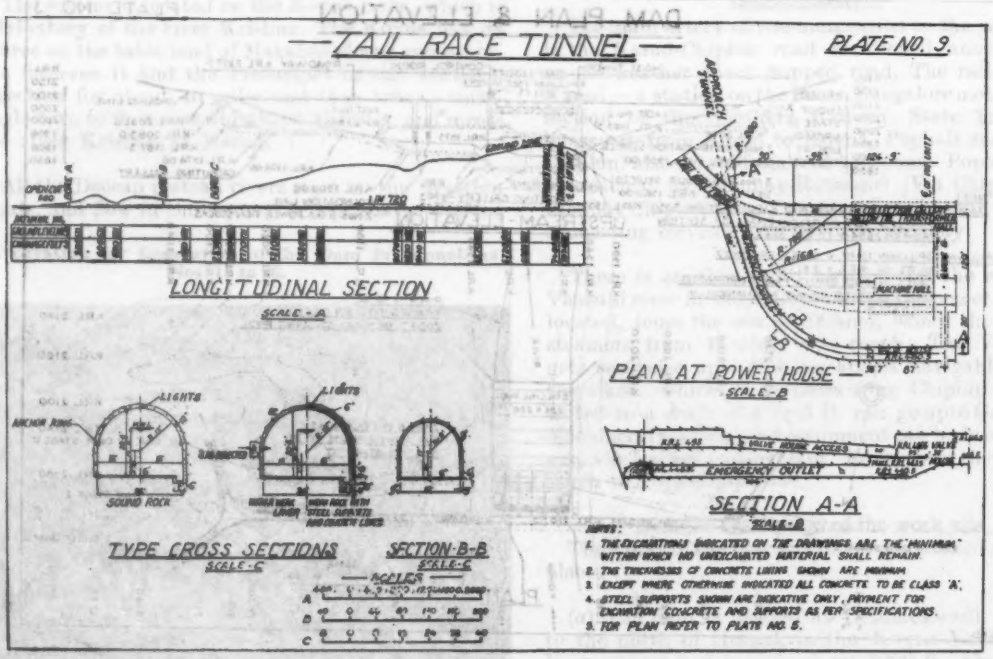


PLATE No 1.
BOMBAY
KANDLA
KHOPOLI
PUNA
BARAMATI
BARSI
SHOLAPUR
WALKOT
JHAMAKAD
FORT DAPHOL
KARAD
ISLAMPUR
RATNAGIRI
VISHNA RIVER
MIRAJ
VIJAPUR
ALMATI
SAGALKOT
SEA
ARABIAN
LEGEND
SCALE
INDEX PLAN


DAM PLAN & ELEVATION
PLATE NO. 3
HOIST TOWER
CAM 2200FT
SPILLWAY (SEE NOTES)
291 FT.
CONTROL ROOM
ROADWAY K.R.L 2107.5
ADIT No 2
K.R.L. 1965
ADIT No 1
K.R.L 1963.5
GROUND LINE
K.R.L 2091-0
K.R.L 2083-0
K.R.L. 1967.5
K.R.L 1974.00
GROUTING GALLERY
K.R.L 1974.00
2 Nos 6'X5' IRRIGATION SLUICES
SILL LEVEL K.R.L 1930-00
3 Nos 6'x6' SCOUR SLUICES
SILL LEVEL K.R.L 1960-00
PUMP
GROUTING GALLERY
K.R.L 1903
K.R.L 1909-00
FOUNDATION LINE
2 Nos 8' DIA. POWER PEN-STOCKS
NOTE
DAM :
CH. 1720 TO CH 2823 AND CH 3175 TO CH. 3220
DAM IS OF NON-OVERFLOW (STAGE II) SECTION
FROM CH 2854-5 TO CH. 3145.5
SPILLWAY :
SPILLWAY IS OF 8 GATES OF 41'X27'
PIERS OF 9 FT. x 291 FT.
GATES IN END SPANS FLOAT OPERATED.
GATES IN OTHER SPANS MECHANICALLY
OPERATED.
UPSTREAM - ELEVATION
RIVER IS TO BE
TRAINED FOR ATLEAST
200 FT. BEYOND STILLING POOL
STILLING POOL
291 X 280
2 Nos 8' Ø PENSTOCKS
FOR POWER-HOUSE TO BE
BUILT IN STAGE III
GROUND LINE
TOE LINE OF DAM STAGE II
END OF DAM STAGE I
AXIS OF DAM
END OF DAM STAGE I
PLAN
N
C.S.D.


DAM: TYPE CROSS SECTION
PLATE NO. 4
CROSS SECTION
THROUGH ELEVATOR TOWER
CROSS-SECTION
THROUGH SPILLWAY AND SLUICE
CROSS SECTION
THROUGH POWER INTAKE


TAIL RACE TUNNEL
PLATE NO. 9.
LONGITUDINAL SECTION
SCALE - A
PLAN AT POWER HOUSE
SCALE - B
SECTION A-A
SCALE - B
TYPE CROSS SECTIONS
SCALE - C
SECTION B-B
SCALE - C
NOTES:
1. THE EXCAVATIONS INDICATED ON THE DRAWINGS ARE THE MINIMUM WITHIN WHICH NO UNEXCAVATED MATERIAL SHALL REMAIN
2. THE THICKNESS OF CONCRETE LINING SHOWN ARE MINIMUM
3. EXCEPT WHERE OTHERWISE INDICATED ALL CONCRETE TO BE CLASS 'A'.
4. STEEL SUPPORTS SHOWN ARE INDICATIVE ONLY, PAYMENT FOR EXCAVATION CONCRETE AND SUPPORTS AS PER SPECIFICATIONS.
5. FOR PLAN REFER TO PLATE NO. 5.

Excavation for Foundation of the Dam in Monoliths Nos. 36 to 38.

(*b*) The inlet works are located in the Navja Valley. Navja is a tributary of Koyna on the right bank and about 5 miles upstream of the dam. Here there is first the intake channel in the Navja valley, the intake tower at its end, and the head race tunnel across the Western Ghat ridge. All these are roughly 2000 ft. above the mean sea level.

(*c*) The power house is under the spur between the Panchdhara and Meri nallas, which are down ghat, near Pophali. These works are about 475 ft. above the mean sea level. The switchyard is on the left bank of the Meri nalla and about 810 ft. above the mean sea level.

It will be seen from the levels of the intake works and the power house that there is a minimum drop of 1525 ft. When the dam is at the full supply level the drop will increase to over 1600 feet. At the end of the head race tunnel there is a very steep escarpment, which is taken advantage of to drop the water through a height which will vary between 1525 to over 1600 ft., to convert potential energy of water into electrical energy.

The principle elements of the Koyna Hydro-electric Project

The complete Koyna scheme consists of elements to serve the following purposes :

(*i*) To store water	For this the dam is provided and will be completed by March 1961.
(*ii*) To lead water across the Western Ghat ridge.	For this, the intake channel and the head race tunnel are provided which will be completed by March 1960.
(*iii*) To drop it safely from level 2000 to level 475 above the sea	For this, the surge tank, the take offs and the pressure shafts are provided and will be ready by March 1961.
(*iv*) To convert hydraulic energy into electric energy and step up the voltage	For this, the machine hall housing the hydro-electric plant with the valve house on one side and the transformers, on the other side is provided. The power house will be completed by May 1959. First machine is expected to go into operation by October 1960 and subsequent machines at 6 months interval, the last will be switched on in April 1962.
(*v*) To lead the utilized water safely to a natural stream.	For this the tail race tunnel is provided which will be completed by March 1960.

One of the novel features of the Koyna Project is that the penstocks, the power house and the tail race, are all underground. Usually in the power houses so far constructed in India, the penstocks have been steel pipes above ground. So also the power house structure has been in the open and the tail race is generally an open channel.

In the Koyna scheme the pressure shafts, which serve the same pu pose as steel penstocks, will be tunnelled through rock. The ¡ ower house comprises of three caverns in rock and the tail race will be a long tunnel. Thus once water enters the head race it will not be seen till it comes in the open at the end of the tail race tunnel.

(*vi*) To raise the voltage of electrical energy to be able to transmit it over long distances.	For this the transformers are provided in a hall parallel to the machine hall.
(*vii*) To collect and transmit energy over some distance to load centres in Bombay & Maharashtra.	For this first an open air switchyard is provided in the Meri nalla Valley. From there three transmission lines will start, two going to Bombay and the third to Karad and other load centres in Southern Maharashtra like Sholapur, Satara, Sangli and Kolhapur.

Foundation for the Tail Tower.

Head Race Tunnel Navja end pit and Crane Lift.

At the end of the transmission line, near Trombay, a receiving station is provided, where necessary transformers for stepping down the voltage to 110 kV and synchronous condensors for regulating the same are provided.

The Dam

The dam is going to be of simple gravity type. It will be constructed in rubble concrete, i. e. usual concrete in which rubble pieces are vibrated in. It is going to be built in two stages. In the first stage, the dam in its deepest portion will be 207.5 ft. above the river bed level and 265.5 ft. above the deepest foundation level. The length of the dam at top in the 1st stage will be 2200 ft.

The total contents of the lake when the reservoir is full is 36045 mcu. ft, the catchment area above the dam is 344.32 sq. miles and the water spread in the first stage will be 20.95 sq. miles.

The Intake Channel

The intake channel is located in the Navja Valley and will function when the water level goes down below R.L. 2040. It is 3720 ft. long. Its bottom width varies from 200 ft. to 21 ft.

Intake Tower

At the end of the intake channel is an intake tower which will be a R. C. C. structure about 210 ft. high. Two gates are provided in the intake tower at the mouth of the head race tunnel, the hoisting gear for which will be located on the top of the intake tower.

As this intake tower will be inside the waterspead, some distance from the shore line, a R. C. C. approach bridge has been provided from a neighbouring hill to the top of the tower.

Head Race Tunnel

This head race tunnel is to take water across the Western ghat ridge to the Konkan side. It is 12040 ft. long, concrete lined and with 21′ inside diameter. The end of the head race tunnel has to be steel lined and is of 17′ inside diameter in this section.

Surge System

The function of the surge system is to protect the head race tunnel against water hammer when the machines are to be shut down or loaded up suddenly and also to enable safe and economical regulation of the flow to turbines. It is rather a complicated structure, consisting of a main high vertical shaft with a sloping side gallery at the bottom with another smaller vertical shaft at the other end of the gallery. The water oscillates in this U shaped structure as the load on the machines varies suddenly and water hammer pressures get relieved.

Emergency Valve Tunnel

Immediately after the surge system there is a tunnel, housing emergency valves. These values are to be used

whenever any of the pressure shafts has to be closed in an emergency or has to be emptied for repairs etc.

Pressure shafts

There will be two pressure shafts in the first stage lined with steel plates and concrete against rock. At the bottom, the two pressure shafts will bifurcate into 4 pipes, which will serve 4 machines. Each pipe will have a valve on it, automatically regulated. The length of the pressure shafts is 2066 ft. and inside diameter varies from 10′ to 8′ 6″.

Power House

The power house comprises of three big caverns in rock, the central one being the machine hall, 651′ long, 51′ wide and about 81′ high. On one side of the machine hall is the valve house which again is a cavern of the same length, 20′ wide and 47′ high. On the other side of the machine hall is the transformer hall, 616′ long, 42.5′ wide and 57′ high. These halls are reached by an approach tunnel from the Meri nalla Valley. The approach turnnel, is 2835′ long, 22′ wide and about 22′ high.

There will be 3 cable tunnels and one ventilation tunnel, rising from the power house to the switchyard. These are small tunnels 6′ to 8′ wide for taking out high tension and control cables. The ventilation tunnel has been provided for suction of fresh air and as an emergency exit.

Inside the machine hall will be located the four units each comprising of an impulse type turbine and generator, directly coupled, of 60,000 kW. capacity each, and all the necessary auxiliary plant. There will be a control room near the power house, by the side of the control cable tunnel.

Each generating unit will be directly connected to a transformer bank consisting of 3 single phase units of 25000 kVA each, stepping up generator voltage of 11 kV to 220 kV. The total transformer capacity will thus be 300,000 kVA.

The Tail Race

This is a tunnel 7450′ long 26′ wide and 20′-6″ high, with a semi-circular roof. This will be concrete lined.

Switchyard

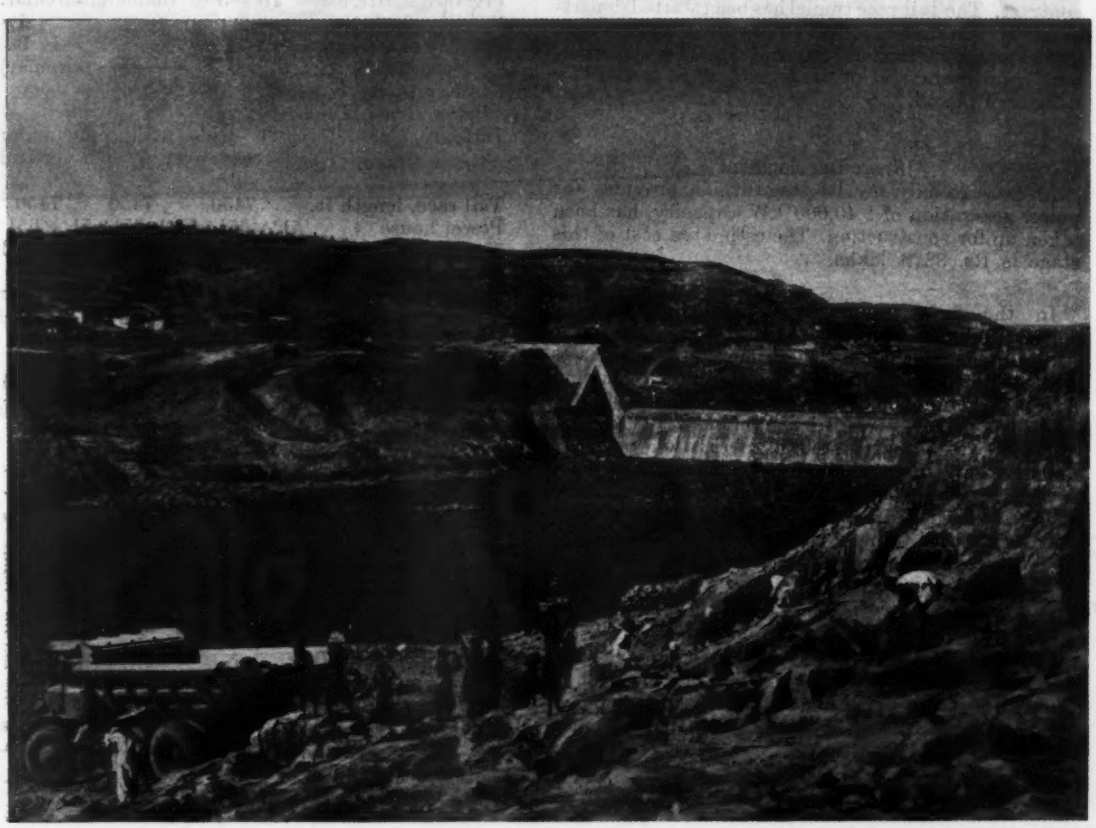
This is a structure in the open, in the Meri-Nala Valley, about 1000 ft. away from the power house. In the first stage it will be 440′ long and 150′ wide.

Transmission Lines

Power for Bombay will be transmitted over a double circuit 0.35 sq. in copper equivalent aluminium steel 220 kV line, about 150 miles in length.

The receiving station at Bombay will be near the Tata's thermal station at Trombay. Here the 3 phase, 125000 kVA, 220/100/11 kV outdoor auto transformers have been provided, along with the necessary switchgear and control equipment. In a building nearby will be provided two synchronous condensers of 30000

Excavation for Foundation of the Dam in Monoliths Nos. 26 & 27.



kVA capacity each to stabilize the system and improve its power factor.

For giving power to South Maharashtra a single circuit 220 kV line will be constructed from the switchyard to Karad with necessary transformers, switchgear etc., by the Bombay Electricity Board, and, the power distributed to load centres by further low-voltage lines.

The power generated in this scheme will be utilised part in Bombay and part in South Maharashtra.

Present Progress

All the preliminary arrangements such as buildings for the staff, roads, water supply for works and domestic purposes and drainage have been completed. A special railway siding at Karad to cater for the project traffic of about 3 lakhs tons of cement, 30,000 tons of steel and heavy machinery and equipment is nearing completion. A diesel power house of about 5000 kW capacity for supply of power for construction equipment, with necessary transmission lines and substations has been installed near the dam site. Necessary services and amenities such as a hospital and dispensary, a bazar area, canteens, primary schools, post office with telegraph and telephone facilities and outposts have been provided.

The principal works such as the Dam, the Head Race Tunnel, the Approach Tunnel, Pressure Shafts, Power House and Appurtenances have been given out on contract. The tail race tunnel has been started departmentally. On the electrical side orders for turbines, generators, transformers, transmission lines synchronous, condensers and other items such as cranes etc. have been placed.

Stage Development

At present only the lst stage which provides for power generation of 2,40,000 kW capacity, has been taken up for construction. The estimated cost of this stage is Rs. 3828 lakhs.

In the 2nd stage the dam will be raised by 63.5 ft. making the height 271 ft. above the river bed in its deepest portion. Two more pressure shafts with 4 additional turbo generators will then generate a total power of 4,08,000 kW. Out of the total storage of 97500 m. cft. then provided about 28,000 m. cft. of water will be earmarked for irrigation purposes and another 11000 m. cft. reserved as carry over. A storage of 67,500 m.cft. will be utilised for power generation. The estimated cost of the power project only is expected to be of the order of Rs. 5200 lakhs (inclusive of the cost of lst stage).

The 3rd stage will consist of one more underground power house further down utilising the tail water from the previous power house and generating 105,000 kW. firm power and another power house at the foot of the dam utilising irrigation water for seasonal power generation of the order of 30,000 kW. The estimated cost is not yet worked out.

Salient Features

	1st Stage	2nd Stage	3rd Stage
(*i*) *Reservoir*			
Catchment area, sq. miles	344.32	344.32	344.32
Capacity at F.S.L., million acre feet.	0.83	2.27	2.27
Capacity at F.S.L. million cubic ft.	36,045	98,780	98,780
Water spread at F.S.L., sq. miles.	20.95	44.54	44.54
(*ii*) *Dam*			
Height above river bed, ft.	207.5	271	271
Length at road level ft.	2,200		
Irrigation sluices	2 Nos.—5 ft. ×6 ft. each.		
Flood gates.	6 Nos.—41 ft. ×27 ft. each.		
(*iii*) *Intake & Head Race*			
Intake channel, length ft.	3720	3720	3720
Head Race tunnel, diameter ft.	21	21	21
Head race tunnel, length ft.	12040	12040	12040
Head pond weir, height ft.			40
(*iv*) *Pressure Shafts*			
Pressure shafts Nos.	2	4	4
Pressure shafts, length each ft.	2066	2066	2066
Pressure shafts, size	10′—8′-6″ diameter circular.		
Forebay shaft No			1
Forebay shaft size.			17 ft. (circular)
Forebay shaft, length ft.			500
(*v*) *Power House Appurtenances*			
Tail race, size	26′ wide with semicircular roof over 7′ 6″ vertical sides		
Tail race, length ft.	7450	7450	7450
Power house	51′×651′	51′×651′	51′×651′
Transformer hall	42.5′×616′	42.5′×616′	42.5′×616′
Approach tunnel, size	22′ wide with a semicircular arch over 10′.9″ vertical sides.		
Approach tunnel, length ft.	2835	2835	2835
Cable tunnel size	6′6″ wide segmental arch over 8″3″ vertical sides.		
Cable tunnel, Nos. & length	1×1240′	1×1240′ 1×1500′	1×1240′ 1×1500′
(*vi*) *Power Generation (kW) at 6% L.F*			
Main power house	240,000	408,000	408,000
Tail race development			60,000
Dam power house (seasonal)			30,000
(*vii*) *Transmission Line*			
220 kV double circuit line for Bombay			150 Miles

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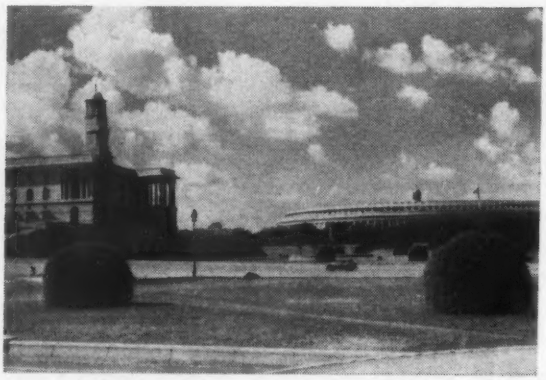

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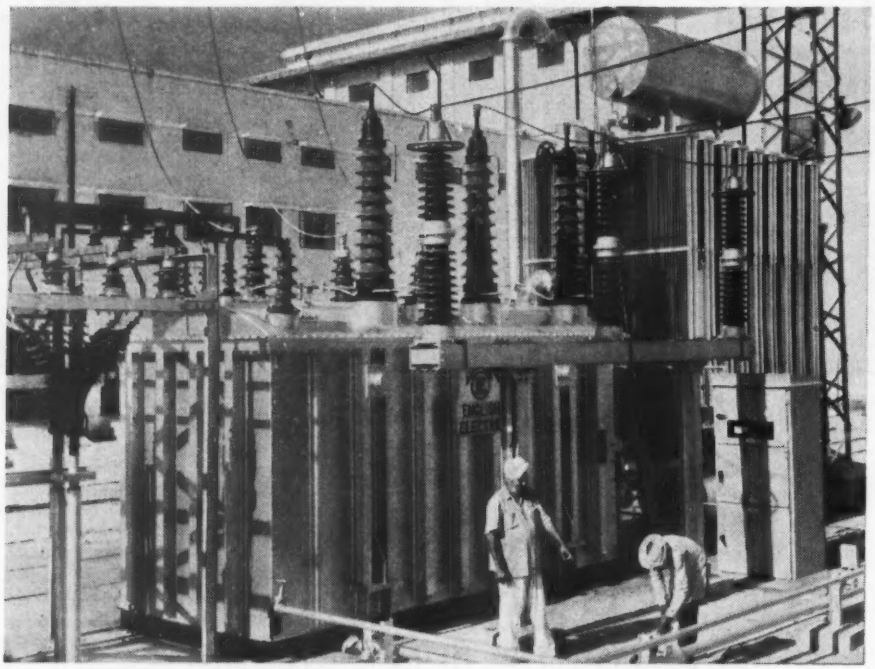

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Concrete work on Bhakra Forges Ahead

By our Special Representative

The work of concreting on Bhakra Dam has made new engineering history in this country. The total volume of 5½ million cubic yard of concrete, which needs to be poured for the completion of this colossal dam has been planned on a scientific as well as a workmanlike basis. The procedures of manufacture and handling of concrete have been based on the latest practice current in America and in this country. New records have been achieved in the peak progress during a single shift or during a day.

Heel-claystone Treatment

The heel-claystone problem at Bhakra Dam has been one of tremendous difficulty. Originally, it was thought that this material lying in situ since geological ages, was sound and compact enough. The original designs have provided for only a cover of about 50 ft. over this strata. Later deliberations and the anxiety to leave no loophole as regards long range safety of the dam and fullest insurance against any settlement, the depth of excavation of heel-clay stone and subsequent filling was raised to about 150 ft. Thus a bottom level of 960 was decided to be reached as a result of deliberations held in several consultations with experts of the topmost level in India and abroad from both the design and construction fields.

Progress of Work

From the beginning of 1957, the work of heel-clay

Concreting in fullswing on the Bhakra Dam. (Sloping portion of the overflow Spillway in the centre.)

The Bhakra Dam progresses rapidly with block formation concrete. Shuttering made at Nangal is in position.

stone treatment got into swing At the end of January, 1957 the first stage of mining operation was completed. Hatches were excavated down to elevation 960. For backfilling of these hatches, cold concrete was manufactured. Originally there was an idea of using prepakt concrete. This new material was however, not considered suitable after trial because some sort of a segregation took place and the prepakt concrete did not give the expected consolidation or adhesion.

New Technique for Handling Concrete

In the hatches excavated below the river bed, the placement of concrete was done by means of the overhead cranes, but subsequent spreading of the concrete was done by means of a bull dozer. This was a relatively new technique, but it proved quite successful. Progress was expedited and the total yardage from overhead cranes was substantially increased at economical cost.

15 months after the placement of the first bucket of concrete by the Prime Minister (17th November, 1955) the first million cubic yards of cement concrete were completed in the Bhakra Dam, on February, 24, 1957.

An air-water jet cleans the concrete. The cooling tubes are spread horizontally over the concrete.

Construction Plant Performance

The construction plant was designed for an average of 5,000 cyd. per day. This average has however been exceeded a number of times. During May, 1957, over 9,000 cubic yards were poured on one day. The monthly overall total of 1,75,000 cyd. was also accomplished during 25 working days.

The handling of concrete is being done by the overhead double cantilever and revolving cranes. These are mounted on trestles and during the progress of work they have to be shifted and re-erected. This is a most difficult and hazardous operation, but it has been successfully tackled in order to equip the left power plant area with concrete placing arrangement.

Progress till end of July

By the end of July, concreting has been completed in the dam from the bottom to 260 ft. height constituting the spillway apron, the spillway training wall, the heel-claystone and the training wall on the dam.

Arrangements are already afoot for the 2nd stage batching plant. The landings are under completion and access roads and footings have been constructed to instal the batching plant.

Features of Heel-claystone Treatment

The features of the heel-claystone treatment deserve notice by the engineering profession. The scheme comprised the following steps :

1. Inorder to avoid the possibility of falling of sides the excavation in the hatches was held by means of pinning rods. Struts were also placed across the hatches in order to provide insurance against settlement or collapse. By this means, the excavation went on in a controlled fashion.

2. Experiments were conducted in Delhi in the Central Water and Power Commission, Photo-elastic laboratory to find out the lowest level down to which the excavation should be done so that the fullest advantage be gained by the backfilled concrete, for purposes of support and distribution of stress.

The trestles and cranes that are building the Bhakra Dam in position. The heavy columns and bridges have all been fabricated in India. The cranes are imported.

Bhakra Dam construction by night—a veritable place of pilgrimage.

It has been verified that no harmful tension or very high compression develops while the dam concrete is being raised with the hatches still lying without being backfilled. It was confirmed by means of laboratory experiments that at no stage did the rock or the concrete get overloaded. There was compression less than 500 lbs per square inch as evidenced from the tests. These tests are rather conservative and in actual working the dam concrete will have better support and the stresses will be still less.

Properties of Clay Stone Material

The claystone material that has been taken out was densed and almost impervious. Its specific gravity was about 2.6 and in dry condition the compressive strength was as high as 2,500 psi on the average. The impermeability was very high. Laboratory experiments indicated that no percolation took place in a remoulded tube under a head of 1,000 ft. The remoulded density was approximately 2.

The only defect in claystone was that it was liable to slaking and softening in the absence of confinement. But this process was more or less superficial. Moisture did not penetrate much below the surface.

Pozzolan used in Mass Concrete

The Bhakra Dam concreting has taken advantage of the use of pozzolan. Natural shale present at the site of the dam has been found on detailed experiments to be a suitable material for the production of pozzolan. Its admixture with cement upto 20% replacement in mass concrete has been proved to be advantageous. Almost full strength is gained at the end of the one year and there is the further advantage of less heat rise and better impermeability. The properties of the calcined shale have been tested and retested and a confirmation of its behaviour has also been obtained from certain foreign laboratories of repute. The Bhakra Project authorities have manufactured a special plant at Bhakra for the production of 100 tons of pozzolan per day. There were initial difficulties about the uniformity of calcination but by proper study and observation, a reliable method of calcination and grinding has been evolved.

Saving in Cement

At this time of acute shortage of cement, the manufacture and use of a local pozzolan has tremendous advantages. Not only economy in money is gained but there is a good deal of saving in transport arrangements. It is likely that even after the construction of the Bhakra Dam the plant designed for the calcination and grinding of pozzolan will be useful for other projects of the country where the raw material for pozzolan production is found within economical transport feasibility.

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Conference of Irrigation and Power Ministers

A Conference of the Ministers of Irrigation and Power from different States was held at New Delhi under the Chairmanship of Sri S. K. Patil in September, 1957.

Among those who attended the Conference were : Shri V. T. Krishnamachari, Vice Chairman, Planning Commission; Shri Gulzarilal Nanda, Union Minister of Labour; Shri Jaisukhlal Hathi, Deputy Minister of Irrigation and Power; Shri J. V. Narasinga Rao, Minister for Irrigation and Power, Andhra Pradesh; Shri K. P. Tripathy, Minister for Planning and Development, Assam; Shri D. N. Sinha, Minister for Irrigation, Bihar; Shri D. S. Desai, Minister for Public Works, Bombay; Shri V. R. Krishnan Iyer, Minister for Law, Kerala; Shri Shankar Lal Tewari, Minister for Public Works, Madhya Pradesh; Shri V. V. Dravid, Minister for Development and Chambal Project, Madhya Pradesh; Shri H. K. Veeranna Geoda, Minister for Public Works, Mysore; Shri Sailendra Narayan Bhanja Deo, Minister for Irrigation and Power, Orissa; Shri Gian Singh Rarewala, Minister for Irrigation and Power, Punjab; Shri Ram Kishore Vyas, Minister for Irrigation and Power, Rajasthan; and Shri Ram Murti, Minister for Irrigation and Power, Uttar Pradesh

The following is the text of the speech of Sri Patil on the occasion.

The Co-ordination Board of Ministers for River Valley Projects is meeting nearly two years after its second meeting in October, 1955. A meeting was arranged at Hirakud in January last at the time of the Irrigation & Power Seminar but most of the members were unable to attend owing to their preoccupations with the General Elections. In the meantime, we found it necessary to reconstitute the Board so as to provide representation to all the States, as reorganized, in view of the far larger programme in the Irrigation & Power sector undertaken under the second Plan.

At the outset, I should mention that the Irrigation & Power Seminars were started by my colleague Shri Gulzari Lal Nanda, when he was in charge of the Irrigation and Power portfolio, to encourage a collective study of important problems common to river valley projects and to pool the knowledge and experience gained by technicians, administrators and experts under diverse conditions. The discussions in the seminars have proved to be of considerable benefit to the engineers and have materially assisted in raising the standard of performance on the projects.

A co-ordination committee was set up to function as a steering committee before each seminar and to take follow-up action on the recommendations of the seminar. As these recommendations on matters of policy were submitted by the top-ranking engineers of the country, a suitable arrangement was necessary not only for taking decisions thereon at the highest level but also for ensuring their speedy and effective implementation by the State Governments. For this purpose, the Co-ordination Board of Ministers was constituted. The implemention of the decisions of the Board is watched by my Ministry. A statement showing the progress of action on the decisions taken at the second meeting of the Board has been circulated for your information. I shall now review briefly the more important subjects discussed at the Hirakud Seminar.

As you know the Rates & Costs Committee was asked to prepare a basic schedule of rates for manual as well as machine work and to recommend suitable adaptations in the existing stores and other accounting rules, procedure, forms, etc. for large projects, and also a uniform pattern of cost accounting units for such projects. The report of the Committee submitted in two parts, was discussed at the seminar and during the discussions some valuable suggestions were made. a few of the recommendations in Part I related to matters which had been considered by Government on the recommendation of other committees and action on which had already been taken. In regard to the others a team of officers has been set up to draw up a synopsis of the recommendations in the light of the discussions at the seminar to facilitate final decisions being taken by the Government and the Auditor General. This report will be available for discussion at the next meeting of the Board.

The question of 'organization and administration of river valley projects' has been engaging the attention of the engineers and administrators for some time past. The general consensus of opinion in the seminar was that Control Board was the most suitable administrative set-up for a major river valley project. The question of evolving a uniform pattern for such control boards, their functions and powers, is under

examination by a study group constituted by my Ministry.

The development programme undertaken in the first Plan in the irrigation and power sector was on a scale without precedent. A study group was set up to go into the question of efficiency and economy on irrigation and power projects in the light of the experience gained during the implementation of the first Plan. The draft report of the Committee, which contained valuable recommendations, was discussed at the seminar and considered by a Sub-Committee. Action is in hand on some of the items. On others, detailed examination is proceeding. The recommendations and decisions thereon will be brought to the notice of the State Governments as soon as printed copies are available.

The development programme under the second Plan is on a far larger scale than under the first, and, with the increasing tempo in the construction activities in the country, extensive demands are made on the limited resources of raw materials like steel and cement In order to conserve the available supplies of steel and cement, discussions were initiated at the seminar to find out suitable alternative materials or to improve on the existing materials by suitable admixtures. The recommendations of the Sub-committee on this subject have been forwarded to State Governments and project authorities for implementation.

The seminar also considered other items like eradication of corruption, silt in relation to irrigation and power projects and the role of forests in flood control.

The Board will be interested to know the present position in regard to some of its important decisions. I am happy to say that the Board's recommendation for constituting the National Construction Corporation has been implemented and the organisation has started functioning. Even on its first contract, the Corporation has been able to quote terms quite favourable to the project authorities when compared with the open tenders received. Only five States are now participating and a sixth State has recently agreed to join. In regard to the others, my Ministry has clarified the points raised by them, and I trust that they will extend their co-operation by participating in the venture and strengthening the organization. I would like to make it clear, in this connection, that the Corporation, is for all practical purposes, a departmental organization for the execution of projects. Our intention in incorporating it under the Companies Act was that it could function on commercial lines unfettered by Governmental red-tape. Actually we have, through the Corporation, achieved a synthesis of the best features of departmental construction and of private construction agencies. Unless the State Governments take this position into consideration while awarding contracts to the Corporation, difficulties are likely to arise in the settlement of details and the smooth working of the Corporation. The Corporation has on its staff qualified and experienced engineers.

In regard to standardisation of machinery, the Standing Expert Committee submitted their final list of equipment to be standardised and orders have been issued in the matter. 'A drill' for the maximum utilisation of serviceable surplus machinery on projects nearing completion was drawn up and sent to all State Governments and project authorities for implementation in connection with the procurement of machinery.

One of the important items that the Board has to discuss is the constitution of an All-India Service of Engineers. This question has been engaging our attention for the last ten years but no significant progress has been made so far. The need for the formation of this service has been supported by the U.P.S.C., the 1949 Economy Committee, the States Reorganization Committee, the Engineering Personnel Committee of the Planning Commission and the Technical Personnel Committee set up by my Ministry. The Sub-committee of Ministers constituted by this Board has gone into the matter very carefully and given their considered opinion. I would earnestly request the States who have not found it possible to agree to the proposal to reconsider the position and co-operate with us in the early formation of this service.

As we are all aware, the foreign exchange position has become very acute. Every possible step is being taken to conserve foreign exchange and in this context it is neeedless for me to emphasise the importance of the optimum utilisation of serviceable surplus machinery. I however understand that there is a growing tendency on the part of the projects and States not to declare machinery as surplus even where they are not required for use immediately within the State. Certain instructions have been issued by the Government of India to counter this tendency but the response has not been encouraging. The Board may like to issue a directive to all concerned in the matter.

There are other items in the agenda dealing with technical personnel, public co-operation, training, and economy in the execution of projects. I am sure that our deliberations today will facilitate firm decisions being taken on the various issues before us.

Recommendations

All India Service of Engineers. The desirability of constituting an All-India Service of Engineers was underlined by the Co-ordination Board of Irrigation and Power Ministers at its third meeting held in New Delhi under the chairmanship of Shri S. K. Patil, Union Minister of Irrigation and Power. The Board requested the States, which had not so far agreed to participate in the scheme, to reconsider the position.

Commending this suggestion to the Board, the Minister observed that the formation of an All-India Service would make for increased efficiency and serve as a unifying factor in the country. He said that the States would have the right to decide whether they could spare an officer or not for working in another State or at the Centre.

The Board accepted the principle of rationalisation of pay scales in various projects under the Central or the State Governments or atuonomous corporations subject to the recommendations of the Pay Commission and the conditions in various States.

Public Co-operation. To encourage public participation in the execution of river valley projects the Board recommended that agencies like the Bharat Sevak Samaj, co-operatives and gram panchayats

might be allotted work at the prevalent schedule of rates without calling for tenders and advanced funds for preliminary arrangements. The Board also suggested that no earnest money or security should be asked for or deducted from their bills.

There was prolonged discussion on the report of the Board's sub-committee on ways and means for ensuring optimum utilisation of available technical personnel and the expansion of training facilities. The Board accepted most of the recommendations of the sub-committee. It agreed that applications from personnel, already employed on a project, should not be entertained by other projects unless the applicants produced clearance certificates from their present employers. This, the Board felt, would prevent haphazard movement of personnel which caused serious dislocation of work at projects.

The Board noted that the Irrigation and Power Ministry had already initiated action on the establishment of employment exchanges at major river valley projects. To ensure security of service for temporary trained personnel, the Board suggested reservation of a percentage of posts by States in their permanent cadre, relaxation of age limits and benefit of past service in fixation of pay and seniority for those with satisfactory records.

In this context, it also accepted the suggestion of the sub-committee for setting up zonal or regional organisations for co-ordinating the demand for and supply of technical personnel.

Training of Technical Personnel

In regard to the training of technical assistants, the Board urged that there should be uniformity in the standard of training and that this should be enforced by an all-India body.

As to the training of operators and mechanics, the Board was of the view that the centres at Kotah and Nagarjuna Sagar should be further consolidated and improved. The Board endorsed the view that the post-graduate refresher course of the Roorkee University should be made full use of by representatives from all States. The States should select graduate engineers for training on river valley projects and in the Central Water and Power Commission in consultation with their Public Service Commissions one year in advance. The Board also urged the States to release technical men from non-technical posts.

The Board recommended to the States to nominate an adequate number of serving officers for training at the Water Resources Development Training Centre at Roorkee. It felt that arrangements made by the Roorkee University authorities helped the trainees to acquire knowledge of the latest developments in the engineering field.

Superannuation Age

Regarding the question of raising the age of superannuation to 58, the Board suggested that the matter may be left to the decision of the States.

The Board urged the States to follow strictly the "drill" laid down for the declaration of surplus machinery to ensure their optimum utilisation and conserve foreign exchange. It also said that river valley projects should have the first preference for acquisition of surplus machinery and the project transferring the machinery and equipment should provide staff to the purchasing project for installation and, where possible, for operation for a short period at the new site.

The Board noted the instructions of the Irrigation and Power Ministry to the State Governments and the project authorities in regard to economy in the execution of river valley projects. These instructions pertain to economy in the use of raw materials like cement and steel, in the expenditure on functions, like laying of foundation stones and on establishments, and increased adoption of indigenous material for construction purposes.

The Board was of the view that the sponsoring Government should bear the expenditure for training of engineers in the technique of dam construction at the Bhakra-Nangal Project.

Continued from page 15

Report on Use of Lime Mortar and Lime Pozzolan Mortar in place of cement

George Oommen, Mr. Clarence Rawhouser, Shri U. J. Bhatt, Shri S. K. Dhawan, Secretary.

It has become absolutely essential to economise on the use of steel due to shortage of steel and foreign exchange and the following measures are suggested to be adopted with immediate effect for the duration of the second Plan period:

Allowable Stress—(*a*) In the case of all tested steels, the allowable stresses are to be 20,000 lbs. per sq. inch instead of 18,000 lbs. per sq. inch for all R.C. structures except as mentioned in sub-para (b).

(*b*) For water retaining structures, instead of 12,000 lbs. per sq. inch, the stress is to be equal to that given by the equation : 16000—40H where H is head of water.

(*c*) Economies due to the use of square and deformed bars are to be studied by the Central Water & Power Commission and proposals in respect of these are to be finalized in consultation with the Chief Engineers.

Extended use of Welding—Welding should be adopted instead of rivetting in structural fabrications and in place of overlapping in reinforced concrete work. Welding should be of high order and be in accordance with the appropriate I.S.I. Code. A detailed recommendation with respect to the extent of such use shall be drawn up by the C.W. & P.C. in consultation with the Chief Engineers.

Adoption of Prestressing Processes—The use of prestressing processes results in considerable economy. A systematic study of the costs and behaviour of the structure already constructed in the country should be conducted and be made available to all the Chief Engineers. For the present, the high tensile steel required for this may be imported and after ascertaining the annual requirements, necessary steps may be taken to manufacture the high tensile steel in the country.

Avoidence of the wastage of Steel—(*a*) In single and double storeyed buildings, no steel should be used for roofs. Lintels requiring reinforcement should be avoided. More extended use of wood, tiles and aluminium may be adopted.

(*b*) In canal systems, no R.C. slabs are to be used in bridges and other structures for spans upto 20 ft. Masonry arches are to be adopted.

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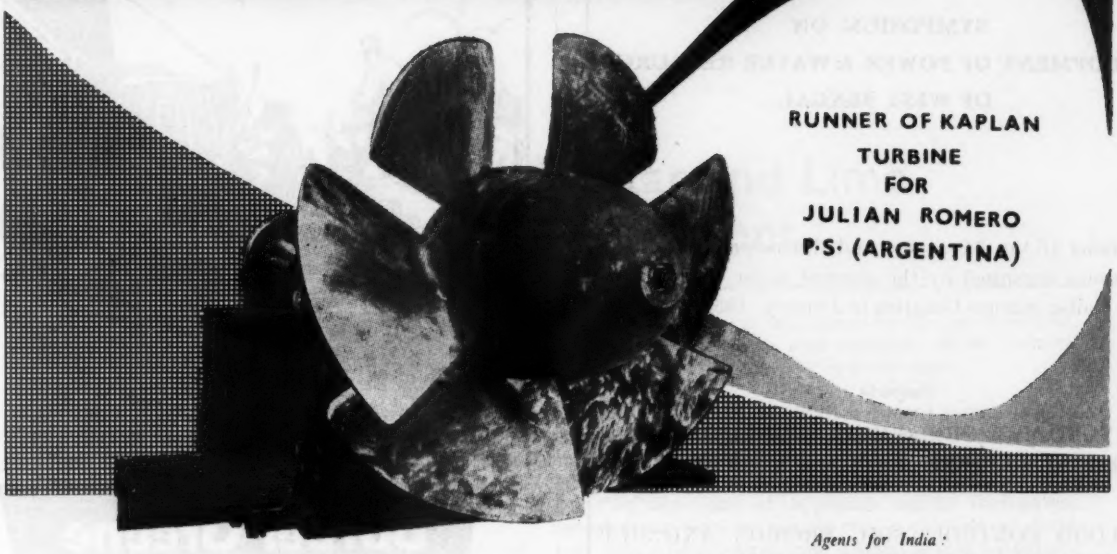

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No. 103 B.F.

Report on Use of Lime Mortar and Lime Pozzolan Mortar in place of cement

The Following is the Report of the Sub-Committee of Engineers Seminar on two vital topics.

Members of the Sub-Committee :

Shri. M. S. Thirumale Iyengar ; Chairman, Dr. K.L. Rao ; Vice Chairman, Shri A. R. Venkataraman, Shri R. B. Chakravarti, Dr. R. C. Hoon, Shri G. N. Pandit, Shri R. L. Khanna, Shri T. S. Murthy, Shri George Oommen, Secretary.

The Sub-Committee considered the use of lime and lime mortar pozzolan in place of cement. The cement production in the country to-day is about 5 million tons a year and the demand of the various users is approximately 14 million tons per year, thus leaving a gap of about 9 million tons. Owing to the very short supply of the commodity in the country and in view of the construction activity envisaged in the second Five Year Plan, the following emergency rules are suggested for saving cement.

Emergency Rules Suggested

(1) No cement should be used in permanent or other type single-or double—storeyed buildings for walls; plastering on the inside must be done in lime mortar, wherever possible. Cement pointing must be adopted in place of cement mortar for plastering to the extent possible. Cement may be used where absolutely necessary in damp-proof courses, lintels, floors and roofs as required.

(2) RCC slab in roofs and lintels to be avoided as far as possible except in earthquake zones.

(3) The above principle should be followed for all buildings in other sectors also to be built in the second Five Year Plan.

(4) All gravity dams or portions of dams less than 100 ft. high should be built in hydraulic lime, lime surkhi or other combinations and the use of cement is to be restricted only to provide top courses for overflow sections, galleries, piers, sluices and such, other special features. (By height of dam is meant the height above average bed level). Where lime or hydraulic lime is not available, efforts should be made to obtain this from the nearest area.

(5) If, in case of some dams higher than 100 ft., it is decided to use cement the proportion of cement is to be kept to a minimum by proper selection, grading of aggregates and ensuring strict control. Maximum size of aggregate is to be used.

(6) When cement concrete or cement mortar is used in dams, it shall invariably incorporate pozzolan in suitable proportion.

(7) In the case of approach roads, foot-paths, paved areas, parking places etc., a pitched or hard core base with a bituminous surface should be substituted for concrete. If a concrete road is particularly desired its construction should be deferred till the end of the second Five Year Plan.

(8) For canal linings, the Committee discussed the possibility of utilizing lime or lime surkhi concrete, in place of cement concrete linings. As sufficient data is not available with regard to the relative behaviour of linings under different velocities, it is recommended to conduct full scale experiment in different parts of the country. The expenses for this may be met from the provision for research in the second Five Year Plan for irrigation.

(9) For canal works, such as cross-drainage works, bridges and falls, lime or lime surkhi mortar should be used as far as possible, as also arches adopted in place of RCC slabs. Cement concrete toppings over lime concrete may be used in places where indicated by design considerations.

(10) It is suggested that CWPC in consultation with Geological Survey of India prepare and supply to the Chief Engineers of the various States and Projects the sources where suitable lime and pozzolanic material are available.

(11) The Central Water & Power Commission must prepare, with the assistance of the various research stations in the country and in consultation with Indian Standard Institution, a tentative standard for lime and surkhi for immediate use.

Report on "Economy in the Use of Steel"

The following were present :

Dr. K. L. Rao, Shri A. K. Char, Shri M. L. Sood, Shri R. L. Khanna, Shri S. Venkataraman, Shri

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Refresher Course on Irrigation Works

The next Refresher Course in Civil Engineering at the University of Roorkee will be held from 15th January to the 14th of April, 1958 for the serving Engineers in the country.

This Course will deal with Irrigation Works. It will be of three months duration and is divided into two parts. Part I on Canals, Tube Wells and Soil Mechanics will be held from 15th January to 21st Febr. ary, 1958. Part II on Foods and Flood Control, Design and Construction of Dams, Water Shed Management and Land Reclamation and Irrigation Research will be held from 8th March to 14th April, 1958. During the period from 22nd February to 7th March, 1958, the trainees will be taken on a tour to important Engineering Projects like Bhakra Dam and other places of Engineering interest, where they will also receive instructions from various specialists at site. This tour is common to both the parts and forms an integral part of training in the Course. Trainee officers are also taken to Delhi and other neighbouring places for lectures, when it is difficult to get the lecturers to come to Roorkee.

Syllabus

Part I—Canals, Tube-Wells and Soil Mechanics. from 15th January to 21st February, 1958.

CANALS

1. Various theories of design of channels.
2. Canal lining and flumes.
3. Hydrology, Collection of Statistics and Selection of Site for Headworks.
4. River training works including Guide Bunds and Groynes.
5. Wiers and Barrages.
6. Silt Ejector and Silt Excluder.
7. Head Regulators and allied works.
8. Cross drainage works and bridges.
9. Falls, Regulators and Energy dissipation below falls.
10. Distributory heads outlets and proportionate distribution etc.

TUBE WELLS

1. Water Cycle, Water Table etc.
2. Sub Soil formation, Porosity, Permeability etc.
3. Tubewell Irrigation Project and siting.
4. Types of tubewells and their design—Strainer Wells.
5. Design of Cavity Wells.
6. Design of Gravel Shrouded Tube Wells.
7. Construction of wells and machinery for the same.
8. Tube-well failures, their causes and remedies.

SOIL MECHANICS

1. Physical and Mechanical Properties of Soil giving its behaviour as an Engineering Material—Basis of Soil Classification and Identifications, Theory of Soil Testing.
2. Soil Investigations, Soil Surveys including Geophysical methods, Soil Profiles etc.
3. Soil Compaction and settlement of earthen embankments, their stability.
4. Principles of Soil Stabilization, Various methods and their constructional processes.
5. Movement of moisture in soils and soil drainage.
6. Stress Analysis of Soils.
7. Mechanical Tests of Soils.
8. Choice of foundations for buildings and bridges.
9. Laboratory experiments.

Part II—Flood Control, Dams, Land Reclamation & Irrigation Research. From 8th March to 14th April, 1958.

FLOODS & FLOOD CONTROL

1. Catchment characteristics.
2. Precipitation, Snow Surveys, Rainfall-Runoff relationship and trends in rainfall and runoff.
3. Flood intensity, duration and volume, Flood frequency, Flood prediction and Flood warnings.
4. Causes of floods and methods of controlling them such as flood absorption, afforestation, bunds, diversions, their construction and reservoirs

DESIGN OF DAMS

1. Basic considerations of design on rock and soil foundations; Rolled fill, Rock fill, Arch, Buttress, Gravity, Composite and other types of dams and their suitability under various conditions of topography, siesmicity, hydrology, material availability and accessibility.
2. Flood routing, spillway studies and spillway capacity.
3. Modern trends in design of dams and spillway on rock and permeable soils. Design of galleries, outlet works, pen-stocks etc.
4. Energy dissipation, stability analysis. Design of blocks and lifts.

5. Instrumentation in dams and evaluation of structural behaviour from instrument observations.
6. Role of dams in basin-wide development and their economics.
7. Aerial Survey.
8. Prestressing theory and practice

CONSTRUCTION OF DAMS

1. Foundation treatment, drilling,grouting treatment of faults and weak zones.
2. Quality control and testing of concrete on large dams.
3. Control of concreting operations.
4. Batching and mixing of concrete for a large dam.
5. Air entrainment in concrete and air entraining agents.
6. Construction of tunnels, blasting excavation, muck hauling, pumpcrete, lining of tunnels, grouting tunnel excavation under pressure.
7. Construction of Coffer dams.
8. Construction machinery:—Earth moving, compaction, rock excavation, drilling, pumping, aggregrate plant, Concrete Plant for processing, mixing and placing, Conveyors etc.

Continued from page 3

WATER SHED MANAGEMENT & LAND RECLAMATION.

1. Types and causes of Soil erosion and its conservation.
2. Causes of formation of Usars and their reclamation.
3. Water logging and methods to combat the same.
4. Silt yield of catchments, Silting of reservoirs, Silt Surveys, density currents, Silt prevention and control.

IRRIGATION RESEARCH

1. Importance and role of Model Experiments in solving river training problems and design of Irrigation and Foold Control works.
2. Electrical Anology Methods.
3. Photo-elasticity.
4. Electronics as applied to precision measuring devices.
5. Testing of Earthen Dam Sections and their design.

TOUR

Visit to important Engineering Projects like Bhakra Dam and other places from 22nd February to 7th March, 1958.

Stalingrad Hydro-electric Station

Fig. 4.—Work on the power house

development is a reservoir holding 32·2 cubic kilometres of water with a surface area of 3,200 square kilometres. This will improve navigation over a considerable stretch of the Volga and a number of its tributaries.

Work on the construction of the stalingrad hydro-electric Station is making good progress. During the first half year, 870,000 cubic metres of concrete were laid. The town of Volzhsky is being erected for the builders on the left bank of the river. When the station has been completed, Volzhsky will become the home of the workers and engineering and technical personnel of the industrial enterprises now going up in the vicinity of the hydro-development scheme.

It is planned to block the channel of the Volga and launch the first generating units at the end of 1958.

Economic aspects of generation of electric power from nuclear sources

The purpose of this section is to bring into focus the factors which enter into the economics of nuclear power generation, to present official information available on the economics of the subject and to provide perspective as to future possibilities. The latter objectives are complicated by the lack of experience in the generation of power by nuclear means and by the fact that technical developments are proceeding rapidly.

On the basis of its technology as conceived today, the exploitation of nuclear energy depends upon the natural occurrence of the nuclear isotope known as uranium-235, and the artificially produced isotopes uranium-233 and plutonium-239. These isotopes, in their nuclear interaction with neutrons, undergo a process called fission, which is accompanied by the release of energy. A device known as a nuclear reactor makes it possible to promote and control the fission process. The energy appears in the form of heat and is removed from the reactor by a suitable coolant. To date, no practical method has been discovered for directly converting the fission energy into any other form than heat. This fact is important, for it requires that conventional methods (e. g. turbine-generator systems) be employed in conjunction with reactors to produce electric energy.

In discussing resources of nuclear fuel it is desirable to distinguish between two types; (*a*) fissionable material, and (*b*) fertile material. The prime fissionable material resource is uranium-235, which is contained in natural uranium to the extent of about 0.7 per cent. Fertile materials known today consist of (*a*) uranium-238, which is predominant in natural uranium to the extent of about 99.3 per cent. and (*b*) thorium, which consists of only one isotope, thorium-232. These materials are called fertile since by nuclear interactions with neutrons in a reactor they can be converted into the fissionable materials plutonium (produced from uranium-238) and uranium-233 (produced from thorium-232), which can be used as nuclear fuels in addition to uranium-235.

Some kinds of reactors can be fueled with natural uranium, while others require enrichment of the content of fissionable material. No matter what fuel is used, however, during consumption in a reactor, products and conditions which interfere with operation are created. The fuel must therefore be removed from the reactor after a certain time. The fissionable material which is left in this fuel or has been produced in a fertile material will in many cases be used for the fabrication of some new fuel. But this is possible only after complicated operations of chemical processing and refabrication.

The process of "burning" a nuclear fuel is therefore much more complicated than the combustion of a conventional fuel. As a consequence the amount of energy which can be actually produced from a unit mass of uranium, for instance, can vary considerably according to the type of reactor used and the way of fuelling this reactor. Thus it is expected that in some natural uranium reactors under construction 3,000 megawatt-days of heat will be extracted from each ton of uranium. This is approximately the equivalent of the heat from 10,000 tons of coal. In this case, however, substantial quantities of plutonium would also be produced in the fertile uranium-238. By recycling and burning this plutonium in a reactor, upto ten times as much energy could possibly be produced from each ton of uranium. It is further hoped that by using a particular type of reactor known as the "fast breeder" it will be possible in the future to increase the amount of energy extracted from uranium by still another order of magnitude. One ton of uranium would then be the equivalent of perhaps one million tons of coal.

This method of producing energy is only on the threshold of its application, and in most conditions its cost is as yet higher than that of available alternatives. Although in the early stages the cost of producing nuclear power necessarily includes support to development efforts, how rapidly the use of atomic energy will go beyond the threshold depends very largely upon the extent to which that energy may be economical under specific conditions. But its ultimate consequences may be quite remarkable in reducing dependence on conventional sources of energy, and because nuclear fuel does not require heavy transport facilities, the possibilities for the economic location of nuclear power plants may be significant in future economic development.

MAJOR ELEMENTS IN COST OF NUCLEAR POWER

As just stated, the cost of producing electric power from nuclear fuel is at present relatively high and this despite the fact that a small quantity of fuel has a

high potential energy yield. There are two major elements : the large total investment needed for equipment and structures, and the cost of providing and using the fuel.

Investment Costs of a Power Reactor

The first major element is the heavy investment called for by the special requirements of a nuclear power reactor, which involves complex engineering construction, and the use of special materials which have to meet unusual performance specifications. Further complications arise because of the presence of radiation, which results in direct costs for shielding and containment and in indirect costs because even conventional equipment used in conjunction with a nuclear reactor may have to meet standards which are higher than usual. Moreover, very great precision is required in the design, manufacture and construction of some parts of the reactor. Although there are many different types of reactors, all of them must satisfy exacting standards and today, therefore, involve heavier capital expenditure than do conventional thermal power plants. The nuclear power plants contemplated for the near future may require as much as twice the capital required per kilowatt for conventional thermal plants, though this difference may be expected to diminish in a more distant future.

As to economies of scale, although there may be some variation among different types of nuclear power plants, costs per kilowatt of capacity will generally be lower for plants of larger size.

Fuel costs

As the investments for a nuclear power plant are high, nuclear power can only be competitive at the generating station if its fuel costs, the second major element in costs, are low. Fuel costs comprise : (*a*) charges to cover investment for fuel inventories in various stages of fabrication, in the reactor and in storage or chemical processing after removal from the reactor, (*b*) charges to cover the cost of fuel material actually consumed in the reactor and (*c*) additional charges for chemical processing and waste disposal. In computing the over-all fuel costs for a particular reactor these charges may be offset in part by credits for the value of such fissionable material as is recovered from the reactor and possibly by the value of other by-products.

The prospects of achieving sufficiently low fuel costs are encouraging. At the present time, however, the lack of knowledge on the technical performance of the fuels as well as on processing and fabrication costs is a source of uncertainty in the cost of nuclear power.

Cost and load factor

For any given reactor, costs per unit of power generated fall markedly as the number of kilowatt-hours sent out increases. To be economic, nuclear plants would need to operate for a large number of hours per year without interruption, and for this reason should generally be integrated with other generating units which can absorb load fluctuations and peaks so that the nuclear plant may be used for base-load operations.

It is important to note that in the preparation of estimates of cost per kilowatt-hour for nuclear power plants a high load factor has generally been assumed.

POWER PLANTS AUTHORIZED FOR CONSTRUCTION

The replies to the Secretary-General's questionnaire show that although great resources have been devoted to the development of nuclear power, its application to the generation of electricity was still mainly on an experimental basis at the end of 1956. Up to that time electric power generated by nuclear means had been provided for public consumption in France, the Union of Soviet Socialist Republics, the United Kingdom and the United States of America by experimental reactors which in most cases were not primarily devoted to the generation of electric power. The quantity of electric power supplied by this means is small except for the United Kingdom Calder Hall plant of some 70,000 kW capacity, officially opened in October, 1956. Even this plant, according to the United Kingdom's reply to the Secretary-General's questionnaire is a dual-purpose plant for the production of plutonium, with electricity as a by-product. This plant is not typical of the power plants to be in operation in the next few years, which are being designed primarily for the production of electric power.

It is expected that by the early 1960s several countries will be using nuclear power for the production of electricity. Projects in operation, under construction or in various stages of planning, provide the most appropriate basis on which to estimate the probable levels and trends of the costs of nuclear power over the next few years. Because of the lack of experience in the operation of nuclear power plants under normal commercial conditions, much conjecture necessarily enters into any estimate of the economics of their operation.

Most of the plants under construction or authorised in the six countries, namely, Brazil, Canada, France, United Kingdom, U.S.S.R and United States are intended to provide experience in construction and operation of nuclear power plants rather than to meet directly immediate power needs. However, some of them, notably those in the USSR and the United Kingdom, are also designed to relieve immediate fuel and power problems. Mainly for technical reasons, the large-capacity plants expected to be in operation by the early 1960s are limited to certain types. At a later stage other types, based upon techniques now being developed and expected to result in greater efficiency and consequently lower cost per unit of output, may be introduced.

The first important thing to bear in mind in examining the various factors which enter into the costs of the power to be generated by the large-scale reactors by the early 1960s is that specific assumptions as to their performance and conditions of operation must be made in estimating costs. Even that part of the construction costs which may be based on prices of marketed materials and on project bids may contain larger conjectural elements than would be the case for the construction of, say, a conventional thermal plant, because of the special engineering problems involved. The conjectural element involved is greater in regard to the judgements to be made on fuel per-

formance, reliability of the plant in operation and its length of life.

Investment costs per kilowatt

The capital cost per kilowatt may be calculated in relation to installed capacity or in relation to net electricity sent out. This latter is more suitable for determining the cost at which power can be supplied for consumption.

The capital outlays for reactors are substantially higher per kilowatt of capacity in small than in large-capacity plants, according to present estimates. Not all systems are equally adaptable to small-power use. Thus, for example, gas-cooled, graphite-moderated reactors using natural uranium at present being developed for large power generation are not suitable for small-capacity use. Other types of reactors technically more suitable for small scale are being developed. By the use of heavy water as a moderator or by the use of enriched fuels, it is possible to go to reactors of smaller capacity. These alternatives, however, involve substantial additional investment. Considerable efforts are being put into developments of technology for small-scale reactors in the United States.

It is important to note that fuel inventories may account for a significant part of capital costs and may differ widely for different reactors. In the case of the United Kingdom, for example, capital costs for the projected plants of 150,000 kilowatt nett electric capacity amount to £115-£125 ($322-350) per kilowatt installed, excluding fuel inventories, and £140-£150 ($392-420) per kilowatt installed when fuel inventories are included. In the United States, inventory costs have been estimated at approximately $93 per kilowatt for a gas-cooled plant of 150,000 kilowatt electric capacity, per kilowatt for a heavy water plant of 250,000-kilowatt electric capacity, and between $60 to $90 for a sodium graphite plant per kilowatt electric capacity.

Costs per kilowatt-hour

To arrive at costs for energy produced, fixed charges, fuel costs and operating costs must be considered. It should however, be remembered, in comparing costs for various reactor systems, that fuel and capital costs are interrelated, and are not interchangeable among different reactor systems.

(*a*) *Fixed charges*

Fixed charges will account for a large proportion of the total costs per kilowatt-hour in the case of nuclear plants because of the large capital investments required although estimates may vary considerably for different type reactors and because of different practices in making estimates.

Depreciation presents a special problem because of uncertainties as to the length of life, which should be attributed to the nuclear portion of the plant. This depends on technological factors of which there is as yet incomplete knowledge. Estimates vary considerably. In the United Kingdom a fifteen-year life is assumed for the nuclear portion of the plant and a thirty-year life for the rest of the plant, while an over-all-figure of twenty years is adopted for the whole plant, taking into account that it may not prove economical in practice to maintain the non-nuclear portion of the plant in operation after the original reactor is taken out of service. Other estimates use a life expectancy of twenty years for the nuclear portion and an expectancy of thirty-three-and-a-third years for the conventional portion of the plant, and assume a life of twenty-five years for the plant as a whole.

Although insurance costs represent a small proportion of total costs, because of special risks and a lack of actuarial experience, they can be expected to be higher than for conventional plants.

Of course the computation of fixed charges is influenced by such factors as the terms under which capital may be obtained and the rates and forms, of taxation, factors which vary from country to country.

To minimize the effect of fixed charges on costs per kilowatt-hour countries now developing nuclear power plants for industrial application plan to operate such plants at a load factor of 60 to 80 per cent. This is true in the Soviet Union, the United Kingdom and the United States of America.

(*b*) *Fuel Costs*

The fuel component of power generation cost of any reactor will depend upon a large number of variables (fabrication, reprocessing and waste disposal, etc) and must, ofcourse, be calculated individually for each particular reactor system. It must be remembered that since fissionable material in the reactor fuel cycle represents a large amount of immobilized capital, inventory charges are made against the fissionable material held in the fuel cycle. At present all supplies of nuclear fuels are government-controlled, and costs of production have not been released. In addition the ability of nuclear power to compete with conventional power will depend to a significant extent on intergovernmental agreements on financial conditions, provision of fuel, fuel prices fabrication and reprocessing of fuels and inventory charges.

(*c*) *Operating and maintenance*

Although operating and maintenance costs represent a small proportion of total costs in almost all estimates for nuclear power reactors, there is a considerable range between the different estimates. For the earlier nuclear plants it is generally assumed that maintenance costs will be somewhat higher than for a conventional plant under similar conditions.

Although by 1960 only a small number of reactors in a few countries will be generating electric power for public consumption, it appears that a substantial increase in the supply of electric power from nuclear sources may take place in the following ten or fifteen years. The extent to which this possibility will be realized will depend very largely upon the effects of technical improvements on costs, and the time required to achieve these improvements.

It may be expected that both capital costs and fuel costs will be reduced as experience is acquired. As various sectors of industry become adjusted to supplying the demands for the construction of nuclear power plants, certain economies may be achieved in production. Since some of the special materials and equipment needed for nuclear power plants are now being produced in small quantities there are many

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British Company to Floodlight Niagara Falls

A contract to floodlight Niagara Falls with a new British-designed colour floodlighting system to replace the existing one has been awarded to the Amalgamated Electric Corporation Ltd., Canadian subsidiary of The General Electric Co. Ltd., an entirely British concern. The contract, awarded by the Niagara Falls Illumination Board, comprised of corporate members from both sides of the border, is worth £55,000.

The floodlights will be mounted on the Rotunda in the Queen Victoria Park, which is the hub of Niagara Parks commanding an unequalled view of the Niagara Falls where some 120 million gallons of water per minute drop 165 feet to the river below. Ten projectors will illuminate the 2,600 ft. wide Canadian Horseshow Falls 1,700 feet away; three more will be directed towards the Upper Rapids, two will light the rock face at the base of Goat Island joining the two falls, and five will illuminate the American Falls 3,000 feet away.

Although they will consume no more power than the 24 floodlights which they will replace, the brightness provided by the new G. E. C. floodlight projectors will be at least four times as great.

The floodlighting system was devised by G. E. C. lighting engineers working in conjunction with the Company's Research Laboratories, Wembley. The initial presentation of the scheme was made to the Niagara Falls Illumination Board last November, and to assist this presentation a tape recording supporting the more detailed and highly technical specification was flown to Canada.

Representatives of the Niagara Parks Commission some four months ago attended a large scale working demonstration of a specially designed G. E. C. prototype projector in a field at Stanmore, Middlesex. A distant hill chosen for its topographical similarity to the falls at Niagara was camouflaged and smoke and water used to represent Niagara Falls. A supply of smoke bombs was obtained from the producers of the new British film "Dunkirk", and cascades of water were supplied by hoses of fire brigades from the G. E. C. factories at Hammersmith and Wembley and the Company's Research Laboratories at Stanmore. "Walkie-talkie" was used to control the demonstration, the recorded sounds of Niagara were played as a background, and a running commentary was broadcast.

The prototype unit was subsequently shipped to Niagara, where the final decision was taken following a demonstration on the falls of the G. E. C. unit and an alternative American proposal. Senior representatives of the G. E. C., London, conducted this demonstration and took part in the final negotiations.

Twenty specially-designed weather-proofed high-current density carbon-arc projectors incorporating remotely-controlled automatic colour-changing devices and wide-beam arrangements will be used to provide a large range of dramatic lighting effects. The projectors, which will be supplied under sub-contract by Savage & Parsons Ltd. of Watford, will be equipped with a forced ventilation system which has been evolved to operate under the varying climatic conditions experienced at Niagara.

Despite modern developments in light sources, experiments at the Company's Research Laboratories proved that the best light source for floodlighting the falls effectively was the high current density carbon-arc. The optical system is provided by a parapoloidal silvered glass reflector approximately 90 cm. in diameter having a focal length of 42 cm. The crater brightness of the arc will be in the neighbourhood of 80,000 candelas per square centimeter, giving a beam intensity of 210 million candelas.

Attached to the front of each projector is a housing which provides automatic colour changes by a series of five 37 in. square colour filters held in metal frames. The filters can be used individually or in combination to provide a range of 15 colours. Each of the large filter frames will be operated by individual motors, and the colour for each projector will be selected and brought into its operating position from a remote switch board.

The weatherproof housing and the automatic colour change mechanism was the result of extensive experiments by G.E.C. lighting engineers. Forced ventilation from a high speed motor-driven blower is provided to prevent rapid fading of the colours due to the heat generated by the arc. This provides a positive air pressure within the housing, which is fitted with a non-return valve, thus ensuring that spray from the falls does not enter and damage the mechanism or destroy the colour media.

Rihand Hydro-Electric Power Station in Uttar Pradesh

The 300 mW Rihand Power Station will be sited at Pipri in the Mirzapur District of Uttar Pradesh and will feed ten key 132 kV Grid Sub-stations of the Rihand Transmission Net-work. Initially the power station will have five 77,000 h.p. vertical Francis type water-turbines coupled to five 55,000 kVA alternators. The complete power station equipment comprising turbines, alternators, indoor switchgear and station transformers are being supplied by the English Electric Company.

As an example of generating plant being built by the Company for other parts of the world, the hydro-electric contracts that are now being executed by the Company for North America alone total over 4,500,000 h.p.

The power plant for the Rihand Power Station is being manufactured at the Company's Works at Rugby and at Netherton in the United Kingdom. The photograph shows the draft tube for the first Rihand turbine assembled and erected in the Company's Works at Netherton. The five draft tubes have been shipped and two have already arrived in India where they are now being assembled prior to erection.

This company has already supplied to the U.P. over 120 mW of hydro-electric power plant and steam turbine plant including that at the Riverside Power Station, Kanpur, which supplies electric power to most of the factories—textile, leather and oil—at Kanpur, the largest city in the State of Uttar Pradesh.

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Economic aspects of generation of electric power from nuclear sources

possibilities for cost reductions as the scale of output increases. Improved fabrication methods, better fuel use and increased "burn-up," reduction in fuel inventory requirements and improved methods of processing and recycling the fuel will lead to an increase in output for a given outlay.

More efficient types of reactors may also be expected to be developed as a result of the experimental work already under way in many countries on a variety of reactor types. In all cases improvements which can be applied to power production are dependent upon co-ordinated and extensive efforts of research and development in many fields. (*Extract from the Report of the Secretary General of the United Nations,*)

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Editorial

After the station identification has been repeated 14 times, the meteorological data is sent out three times per broadcast. Between the second and third repeats the wind and rain gauge totalizers are reset at zero, as a means of checking the perfect functioning of the equipment.

The broadcasts in Morse code require no special receiving equipment and can be heard by any radio operator. The length of an entire broadcast is less than two minutes, during which time (after the 40-second station identification, which gives the listener time enough to tune his receiver properly) the data is transmitted three times.

With eight broadcasts every 24 hours, the daily consumption of the station is 2 ampere-hours at 24 volts. If there is no wind at all to run the generator, the station is capable of operating four months with a normal battery power of 250 ampere-hours.

The watertight cabinet, the chronometric equipment and the batteries are installed inside a shelter built according to regional and climatic conditions.

The thermo-hydrometer unit is placed in a special, individual shelter located about 100 feet from the main station shelter, as is the rain gauge.

The wind gauge and wind vane are placed atop one of the pylons which also serves as an antenna. The wind-powered generator is on the upper part of a tripod, also used as an antenna.

The pylons are built on the vertexes of a triangle with sides measuring 65 feet and located in an open area, with no important obstacle (hill, screen of trees) less than 660 feet from the wind gauge and wind generator pylons.

Editorial

With the acceptance of the Welfare State and planned economic development allocation of capital resources is becoming highly centralised. Side by side with this, a concomitant grievance is developing in many minds that these resources are not being equitably and fairly distributed. Whether there is any real justification is such a criticism or not only facts can show. But unfortunately such a grievance is being seriously nurtured in the South, both among the educated as well as the rest. Therefore, it is but proper that an analytical statement covering at least the last 10 years be placed before the country. But more important than this is the urgent need to formulate a proper set of criteria to select projects for execution and for allocation of capital resources, so that each decision may be tested and measured publicly to the satisfaction of democracy. In the absence of such a set of agreed and publicly known criteria, democracy degenerates into a mere scrable for power and those who have the maximum pull with the powers-that-be reap the most advantage whether merited or not.

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Automatic Meteorological Stations

Setting up a wide network of weather observation stations is not always an easy task particularly in out-of-the-way parts of the country. Personnel and communications problems are often difficult and costly. It is, therefore, of great interest to learn of the recent French equipment which is mostly automatic in nature. After preliminary studies and design supervised by the National Meteorology Department, a French firm now builds a complete unit for transmitting by radio (or by cable) the principal elements for meteorological observations (pressures, temperatures, humidity, direction and speed of winds, rainfall) over a distance up to 950 miles.

Normal Morse code is used for radio telegraphy transmission, and can be picked up by any ordinary receiver. Traditional, proved measuring devices that have been used for many years by meteorological services determine the values of the weather elements. Radio transmitters and similar equipment were chosen for sturdiness and simplicity, so as to assure a perfect functioning of the automatic station. Units of this type have been in service for several years in the Sahara desert and in Madagascar.

The use of automatic stations means a considerable saving. With the regular information broadcast automatically every three hours, only one qualified observer is necessary to keep climatological records and to make additional observations.

The station is run by a series of batteries kept in constant charge by a windpowered generator, also of French construction. Meteorological equipment includes :

—a barometer,
—a thermo-hydrometer,
—a wind gauge, provided with a tolatizer for measuring wind speeds during the 10 minutes preceding the observation,
—a wind vane,
—a rain guage, also provided with a totalizer for measuring rainfall since the previous observation.

Two independent radio transmitters are tuned to different wave lengths, one for daytime use and the other for night broadcasts. A mechanical translator, governed by a clock, makes the round of all the metoroligical equipment every three hours, transcribes into Morse code the various information to be broadcast, and chooses the proper transmitter according to the hour. Most of this equipment is housed in a watertight cabinet.

Aside from the series of batteries, the wind generator and the pylons, equipment outside the cabinet includes the horocontactor and its regulator, the wind guage, the wind vane, the thermo-hydrometer and the rain guage. A network of cables with detachable plugs connects the units.

At prescribed hours and by means of relays, the chronometric device selects the radio transmitter which is to broadcast and starts the translator on its rounds. At each broadcast, the station sends out the following meteorological information :

—atmospheric pressure in half millibars.
—air temperature in half degrees Centigrade.
—relative humidity in hydrometric degrees.
—average wind speed, based on a 10-figure code, during the ten minutes preceding the broadcast.
—wind direction in terms of a compass card.
—rainfall since the preceding broadcast, in a 10-figure code.
—indication of rainfall at time of broadcast.

The meteorological instruments used are of a current type in which the recording cylinder has been replaced by a two-scale contact stud collector (units and tens).

When the translator reads an instrument, the style of the instrument touches a collector, and according to the contact stud touched, completes the circuit to one of 10 cams on a reading unit. These cams move in front of two series of 10 brushes, each series being connected electrically to one of the contact stud scales of the instrument collectors (units or tens). When the current reaches the collector, and therefore one of the brushes, a Morse signal is broadcast, governed by the boss on the corresponding cam. If the style should touch two neighbouring contact studs simultaneously, two neighoring cams of the reading unit are activated. The bosses and adjustment of these cams are such that the two cams on charge produce a third Morse signal, different from that which is broadcast if only one of the cams is on charge. This unique method enables pressures to be read in half millibars and temperatures in half degrees Centigrade.

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Letters to the Editor

I have read with interest the MAITHON DAM SPECIAL ISSUE, 1957 of your Journal published on the occasion of the opening of Maithon Dam of the DVC. The article by Sri. P. S. Rau, Chairman, DVC, "SOME THOUGHTS ON DAMODAR" is really illuminating and inspiring. The grand vista of power development schemes opened by him is thought-provoking.

Sri. Rau has mentioned that the DVC is comtemplating to build another (third) thermal power station nearabout Bokaro in the Jharia coal-field areas. I have no doubt that all the skill and judgement of the DVC engineers have been brought into play before the final selection of site, but I would like to put forward a few points which may be worth pondering before locating the major thermal station.

The load centre of the DVC System will be at the eastern end on account of the highly industrialised areas of Calcutta and Jamshedpur and it will be so for all time to come. The above areas are far away from Bokaro region and transmission of large blocks of power from such long distance over the existing transmission system of the DVC, which will be fully loaded, will invariably present problem of voltage regulation and security of supply under line outage conditions. It is, therefore, very likely that with the addition of the third thermal power station in Bokaro area, the DVC will be forced to build additional long high voltage transmission lines to meet the demand for power satisfactorily involving capital expenditure of several crores. Transmission of power in such case will be subject to more weather hazard and costlier too, if the load centre is further away.

Availability of water will be problematical if the proposed station is situated upstream of the Flood Control Reservoir. It will ofcourse be costlier in any case. Whereas water supply will be assured and obviously cheaper, if the station is built further down-stream, i.e. below the confluence of Barakar and Damodar.

The above indicates a more easterly location than Bokaro area. Nearer the location to Calcutta particularly when there are sufficient provisions for extensions of the power stations of the DVC and the West Bengal Government now under construction at Durgapur, the cost of power will go down considerably on account of transmission, lesser transportation charges of the equipment of the generating station from the port to its site and colony and colony services.

Coal supply will not be costlier down-stream. The benefit that will accrue from the less transportation charges of midlings from the projected coal washaries to the proposed thermal station in Bokaro area will be largely offset by the other disadvantages stated earlier.

The matter, however, needs very careful and thorough study with an open mind by all interested in the overall national interest. I would request you to kindly obtain the views of Sri Rau on all the above points. I would also request you to publish my comments and Sri Rau's views on it in regard to the article in one of your future issues of the Journal.

6, Iswar Ganguli Street,
Calcutta - 26

Prabhat Kumar Mitra,
Chartered Engineer

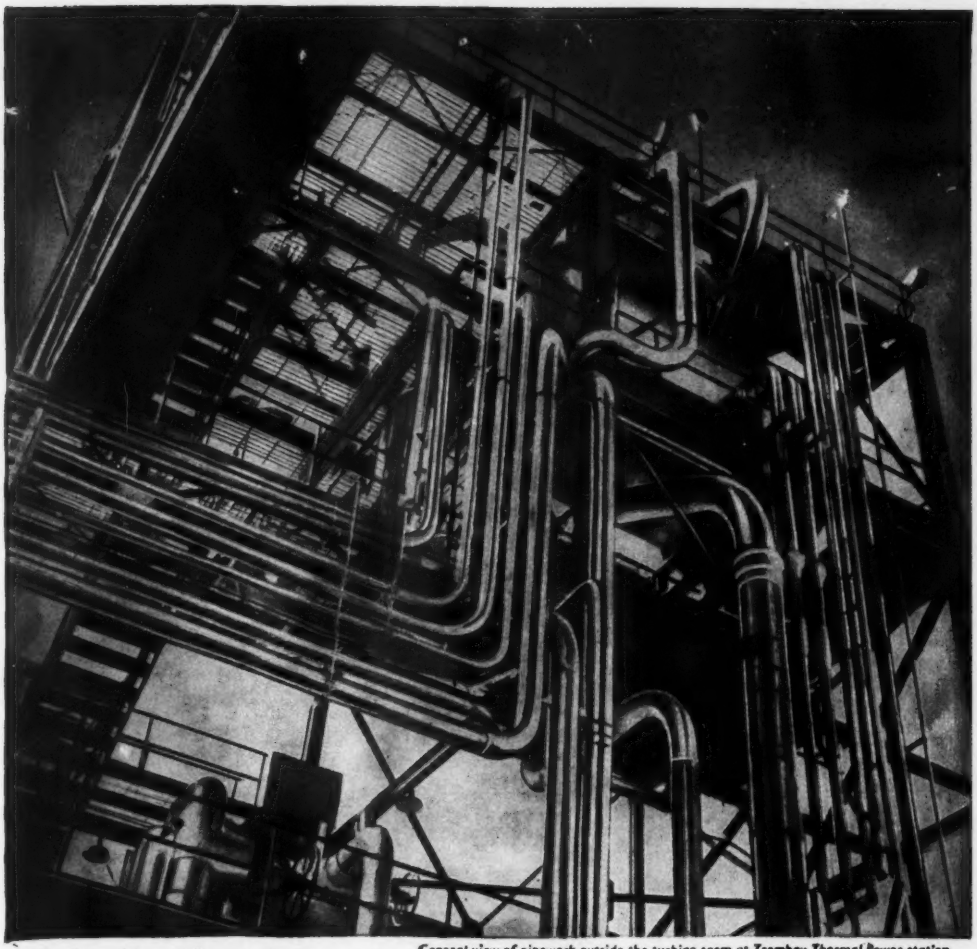
* * *

Thank you for your letter No. PJ :ED-22297 dated the 26th October, 1957. I am glad my article has made people think. That was my object.

It is clear that a large additional thermal power station is urgently required. My first reaction was Bokaro as it is there that the next large block of loads are expected to come up, namely the fourth Steel Unit near Bokaro and the Heavy Engineering Project at Ranchi. Investigations are now in hand to determine the best location for the power station and I am sure that my engineers would give due weight to all the relevant factors including those mentioned by Shri Mitra in coming to a decision.

Damodar Valley Corporation,
Anderson House,
Calcutta - 27

P. S. Rau,
Chairman



General view of pipework outside the turbine room at Trombay Thermal Power station

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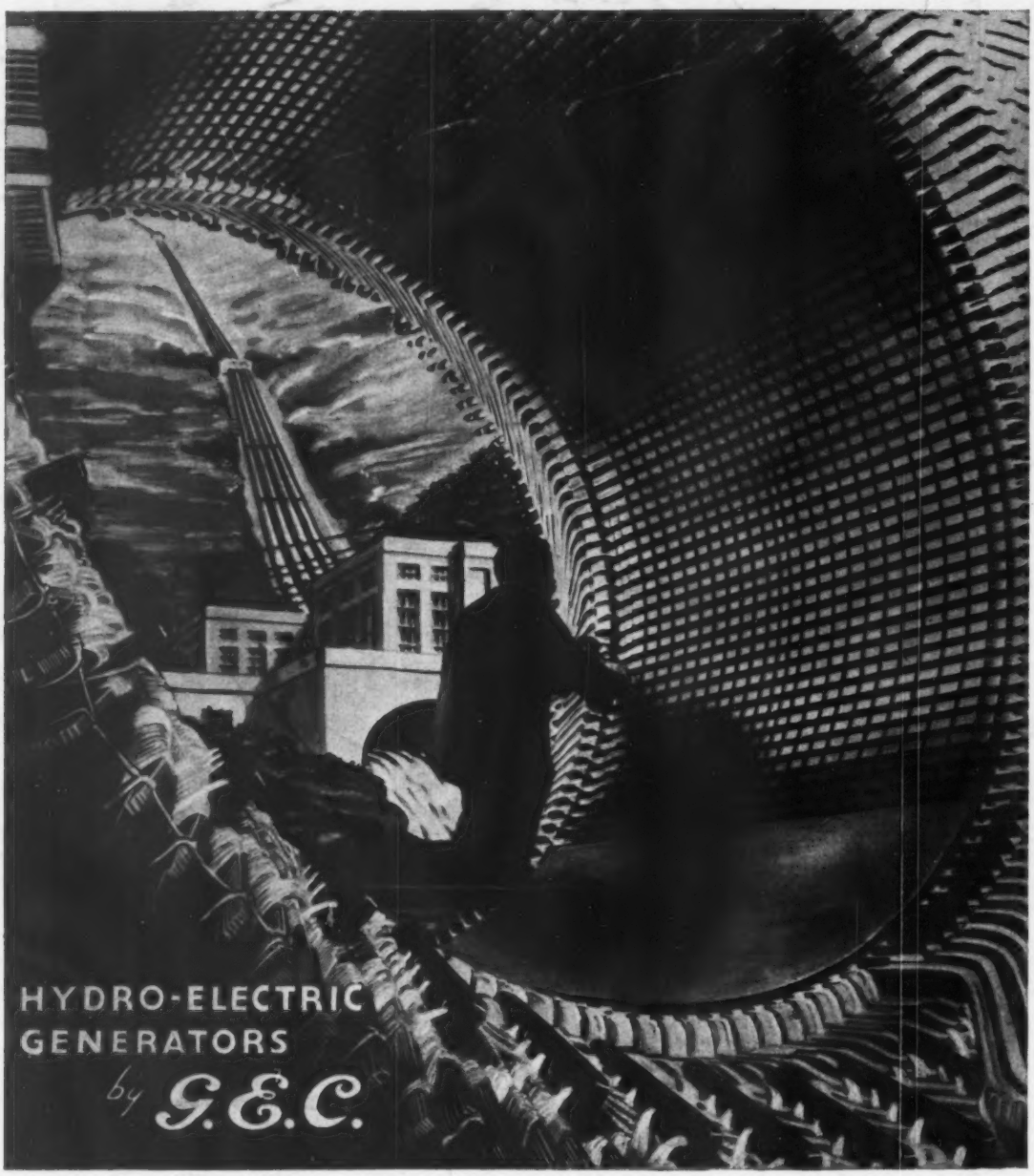

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